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LARGEST AND LONGEST WELDED GAS MAIN EVER BUILT LINED UP FOR TRENCHING THROUGH A STRETCH OF SOUTHERN TIMBERLAND

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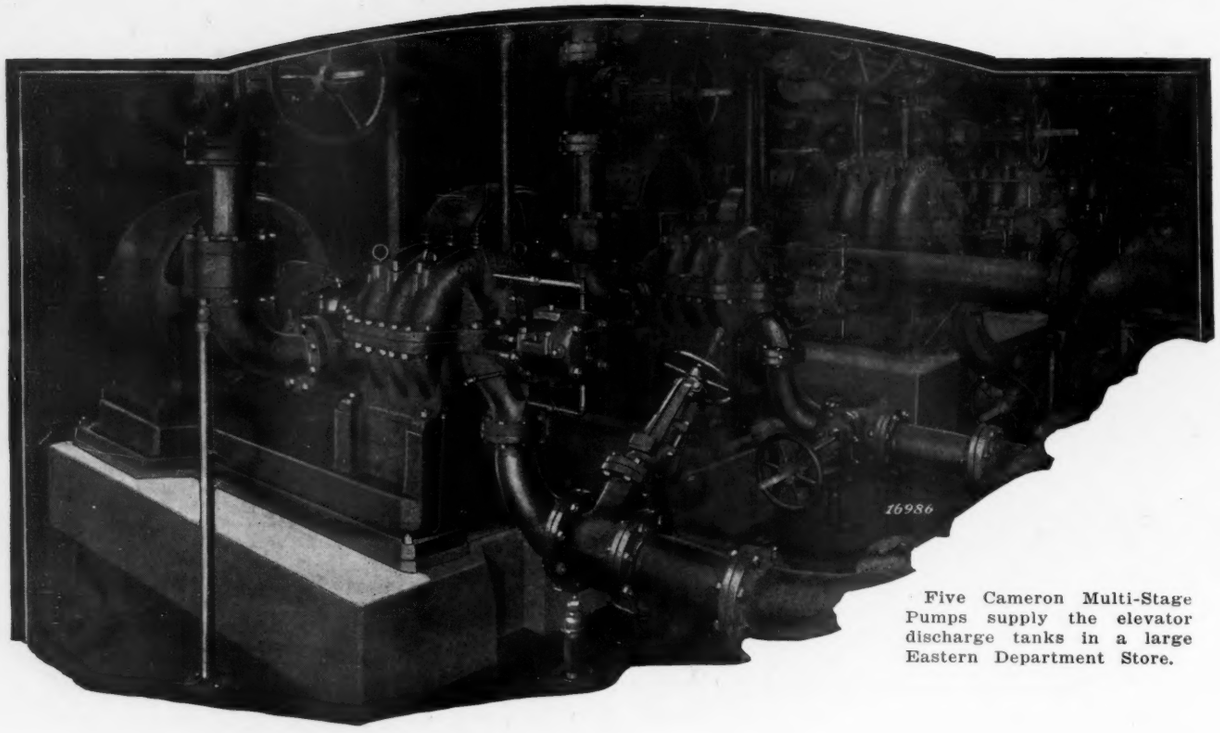

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VOL. XXIX, NO. XII

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DECEMBER, 1924

Turning Out Daily Hundreds of Tons of Newsprint

What is Done at Millinocket, Me., in the Biggest Mill of Its Kind in Existence

By A. S. TAYLOR

TUCKED away in the heart of Maine, on the west branch of the Penobscot River, and with Mount Katahdin looming high in the distance to the north, is situated the little town of Millinocket. The community has its being principally because of the Great Northern Paper Company which established there, in 1899, the first of the local mills for the manufacture of newsprint.

When work was begun upon that plant far-flung stands of spruce timber were within easy reach of it—in fact, the mill was reared there for that reason and because the Penobscot could be counted upon to furnish a great part of the motive energy required in converting the raw material, logs, into enormous rolls of white paper. Today, much of the wood transformed into newsprint at Millinocket journeys 200 miles to get there, revealing how the neighboring forest lands have ceased to be a sufficient source of supply.

It is doubtful if more than a small percentage of our newspaper readers are aware how our utilization of pulpwood for paper making has grown apace latterly. According to the United States Department of Agriculture: "Pulpwood made its first appearance in the census reports of 1869, but contributed only a little more than 2,000 cords to the raw materials used that year in manufacturing approximately 386,000 tons of paper. Before the end of the next twenty years the great growth of the American industry had begun, and by 1889 paper output of the mills had passed 930,000 tons. It doubled again during the following decade, and more than tripled between 1899 and 1922." The consumption two years ago amounted to about 5,847,000 tons of new wood pulp which, in its turn, represented the utilization of 9,148,000 cords of pulpwood.

Millinocket, today, is really the administrative center of three of the company's newsprint plants and of one sulphite mill. We shall confine our story in the main to a description of what goes on at the Millinocket plant, which is the largest of them all and has a production nearly double that of the other mills. Before doing so, however, it should be mentioned that newsprint is composed of from 70 to 80 per cent. mechanical pulp and from 20 to 30 per cent. sulphite pulp; and the pulpwood, which is spruce, is treated differently in each case to render it fit for paper making.

IN THE course of a year our news presses handle more than 2,450,000 tons of paper so that each and all of us can keep continually in touch with current events. As a matter of fact, fully 31 per cent. of all the paper consumed in this country annually is what is known to the trade as newsprint.

Newsprint is a comparatively cheap commodity; and its manufacture is a quantity-production problem. Only a relatively small part of the public knows how cordwood is converted into paper for the spreading of the news, and yet its making concerns well-nigh everyone of us.

In the accompanying article is described the fabrication of newsprint at the greatest paper mill of its kind in operation today. The story is a record of mechanical and chemical achievement that is well worth the telling.

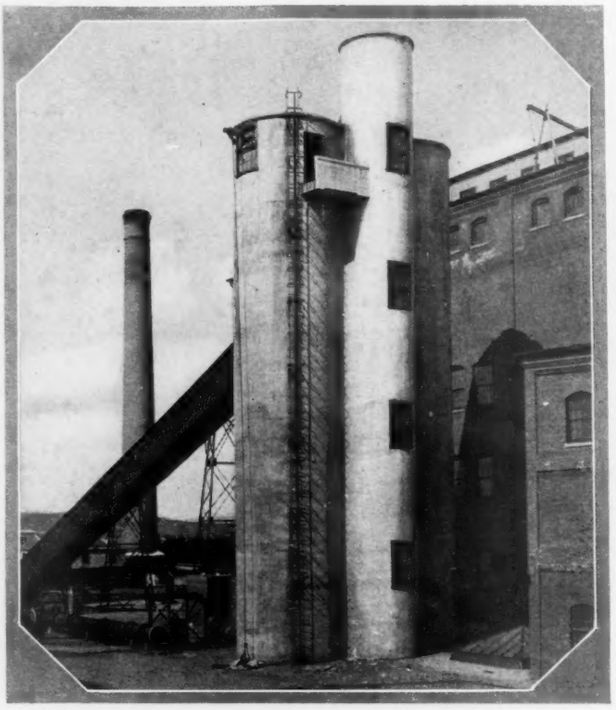
It might be well to note that paper has been made from other woods, even of such hard woods as oak, pine, etc. The cost of these hard woods is too high when used in sufficient proportions to manufacture newsprint having the characteristics now required. The sulphite pulp, which is a chemical product, is added to the mechanical pulp to give the finished newsprint sufficient strength for the service expected of it. In short, sulphite pulp is three times as strong as mechanical pulp, and this is principally due to the greater length of the individual fibers produced by the sulphite process.

To avoid confusion we shall follow through, step by step, first the procedure in making mechanical pulp and then the operations by which wood of the same sort is converted into sulphite pulp. The manufacture is practically a continuous process carried on night and day, and this explains how it is possible to turn out enormous quantities of newsprint ready to be run through the printing presses of some of our largest newspaper plants.

The logs reach the mill either from the company's domestic timberlands or arrive from Canada. No matter what the source, the sticks have been cut in 4-foot lengths in the woods and are floated to the plant or delivered there by rail. The latter stock is commonly peeled before shipment, but the logs that come by water are peeled at the mill by being tumbled into big open-ended, revolving cylinders called "barking drums." The wet logs are banged about against the steel sides of these electrically driven drums, and this abrasive action serves effectually to strip and to tear the softened bark from the sticks. After barking, the logs are shot down flumes either to the mechanical stackers or into the wood room, where they are put through grinders or sent to chippers—depending upon whether they are to be used as the basis for mechanical or for sulphite pulp.

Some of the dry logs that are not barked are run through barking drums in the wood room. If, after coming from these drums, any of the sticks are not completely peeled they are taken from the mechanical conveyer and dropped into a near-by tank for a short soaking. From the tank they are floated to other barkers, which are rapidly revolving disks equipped with sharp blades, and the bark removed. Over-large logs are then split by a wedge-shaped knife—a power-driven mechanical axe. All sticks that are to be fed to the grinders

are run between circular saws to cut them into suitable length for grinding, while the logs that are to go to the chippers for use in the making of sulphite pulp do not require further cutting. Short ends or butts are usually burned in the boiler house and help to raise some of the steam required for different services in the mill. So much for the preparatory handling of the wood. Now let us see what is done in turning the pulpwood into mechanical pulp ready for paper making. .. In the grinder room there is a large battery of grinders. The power to drive these grinders is furnished by waterwheels which, in turn, derive their power from water that is fed from near-by Ferguson Pond through headgates. Through three pockets on each grinder logs are fed to the machine and are forced sidewise by hydraulically operated pistons against a grindstone. These stones are about 27 inches wide and 54 inches in diameter when new, and revolve at a speed of from 225 to 250 revolutions a minute. Some idea of the friction developed can be gathered from the fact that the ground wood issues from the grinders at a temperature ranging from 150 to 175°F.



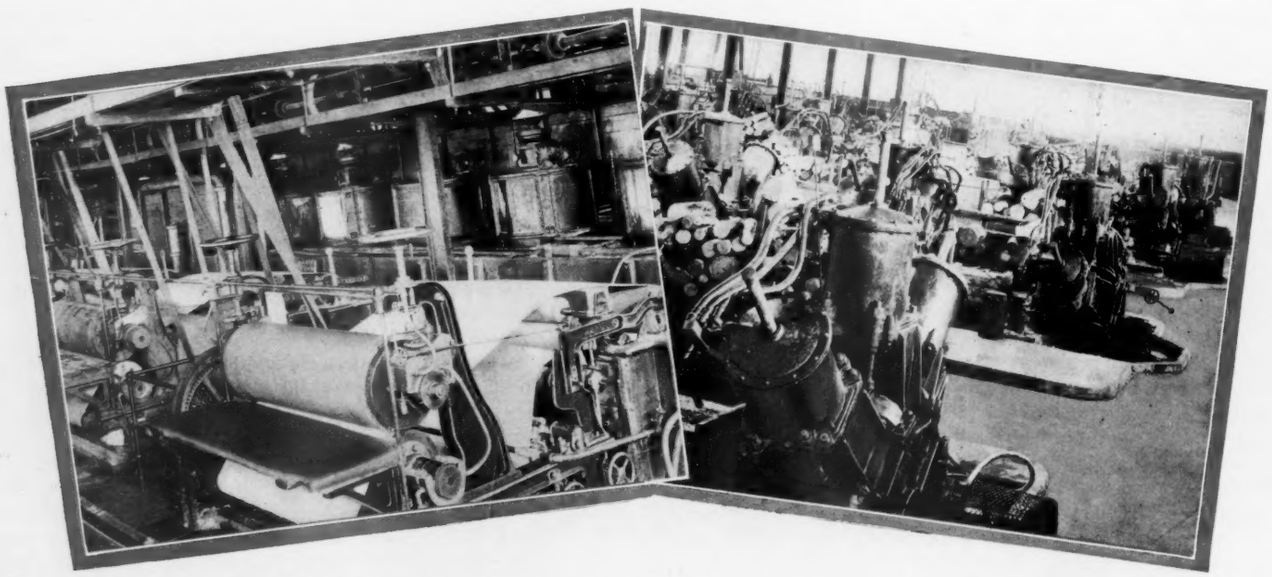
Jennsen acid towers in which limestone, water, and the gases from burning sulphur combine to produce sulphurous acid used in the sulphite process.

It will be understood that water is fed to the grinders to cool the stones and also to make the pulp flow easily from the machines. The pulp is further diluted with "white water"—waste water from the paper-making machines, and in this condition it is pumped to rifflers which represent the first stage in the screening operations. A riffler is really a great steel comb which serves to remove slivers and other coarse pieces from the streaming pulp. After passing through the riffler rack, the pulp is pumped to the ground-wood screen room where it goes through a series of screens. These screens are sometimes called "knotters," because their operation is confined to removing the smaller knots not arrested by the riffler.

From the knotter the pulp is sent to centrifugal screens which are covered with fine mesh, and this is the last step in the finished screening. Having thus brought the pulp to a state of comparative finish or purity, the succeeding operation is designed to remove a considerable percentage of the water content so far needed to facilitate handling. Therefore, the pulp is sent through thickeners. These are likewise screens of a sort which, in revolving, catch the pulp on their outer surfaces and allow the excess water to penetrate them and to be carried away. Upon leaving the thickeners, the ground wood pulp is pumped to a great stock chest where it is held until it is drawn off for admixture with sulphite pulp.

Now let us return to the wood room and from there take up the different operations employed in making sulphite pulp. The first step consists in feeding logs endwise to the chippers to reduce the sticks to chips of varying widths and lengths. The purpose in cutting the chips in this manner is to facilitate later on the penetration of the acid into the wood and thus to dissolve the intercellular resinous matter which must be removed so that the individual fibers can be released. These fibers are pure cellulose, and their function is to impart essential strength to the ultimate newsprint.

A chipper consists principally of a large and rapidly revolving wheel on which are mounted four knives that can be adjusted to cut any desired size of chip. The chips are delivered by a conveyer to vibrating screens, and the final over-size material is usually transported mechanically to the boiler house where it is burned. Upon leaving the screens, the chips of acceptable size are handled by conveyers and hoists which deposit them in a great V-shaped bin situated above and extending from end to end of the digester room. This room is really the upper floor of the digester department; and most of the bodies of the tow-



Left—At the extreme right are rotary screens which handle the sulphite pulp before it is fed to the wet machines, in the foreground, which produce "laps." Right—In the grinder room where 4-foot logs are fed against rapidly revolving grindstones and quickly reduced to mush-like masses.

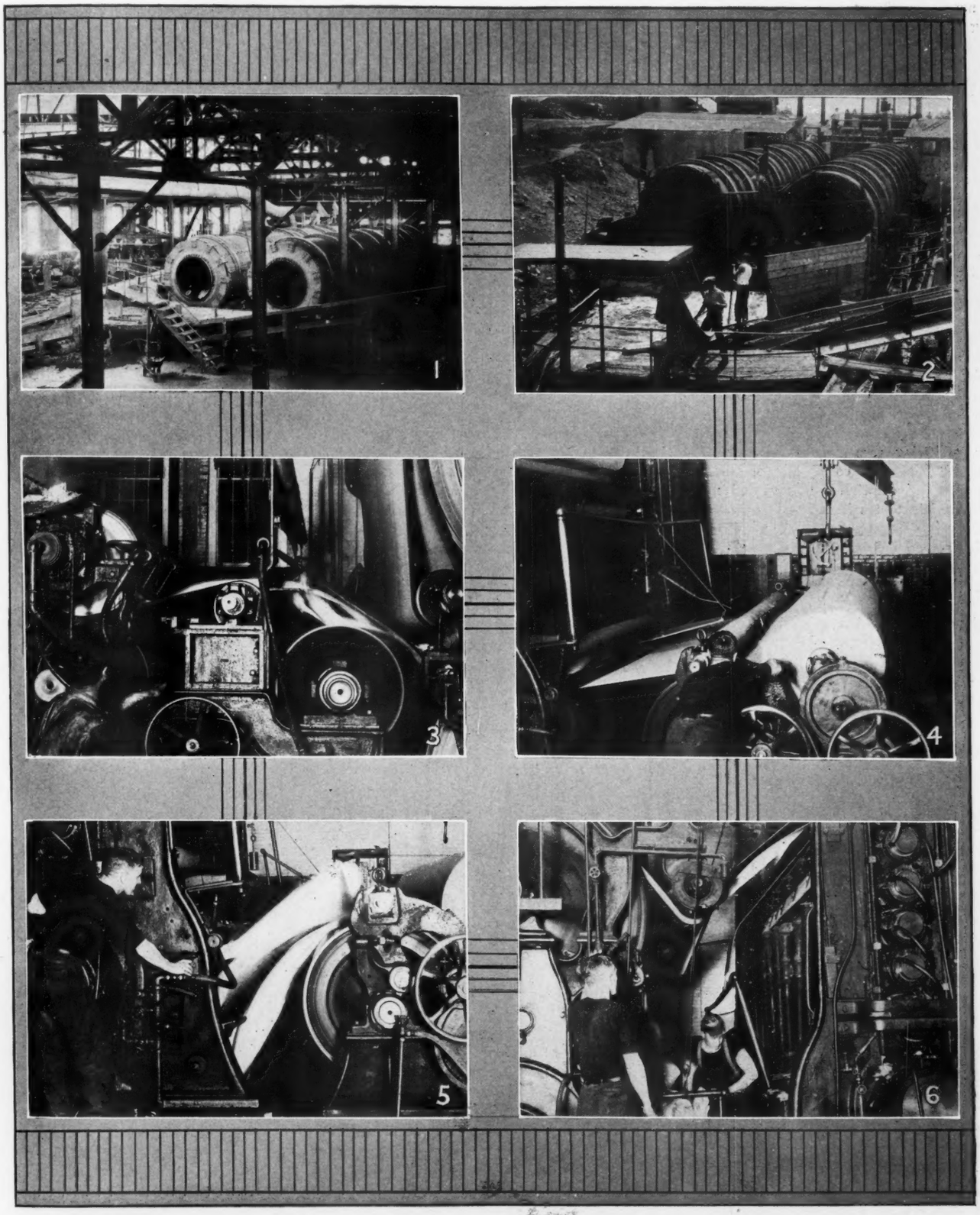
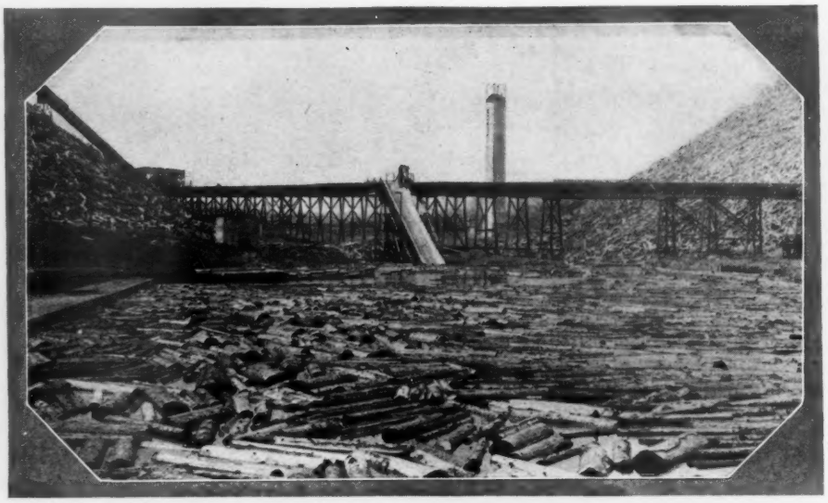


Fig. 1—A corner of the wood room. Here we see the two revolving drums which bark dry logs that have reached the plant by rail.
Fig. 2—Big revolving cylinders of steel within which the wet logs are tumbled about and stripped of their loosened bark.
Fig. 3—Air jets at the fourth press assist the damp paper to jump across to the baby drier—the first of the drier rolls.
Fig. 4—When a reel has been filled, a strong air blast from a half-inch hose cuts the sheet crosswise, severs it from the completed roll, and presses it against the surface of another winder bar.
Fig. 5—Streams of compressed air carry the end of a new sheet of paper from the calender stack to the reel.
Fig. 6—Compressed air blows the narrow strip of a new sheet from the last of the drier rolls to the first and uppermost of the rolls of the calender stack.

ering digesters lie below this floor—only their tops being visible in the digester room.

Each digester is a great cylindrical tank approximately 15 feet in diameter and from 45 to 50 feet high, built of thick iron plating heavily riveted to insure ample strength. Inside, the digesters are lined with tiled brick to protect their metal walls from the corrosive action of the acid used in treating the chips. A digester, at a single charge, holds chips made from substantially 27 to 30 cords of wood; and every digester is equipped with a thermometer, a pressure gage, and a steam flow meter—all being recording instruments. By means of these the "cook" controls the digesting process, which covers a period ranging from eight to ten hours.

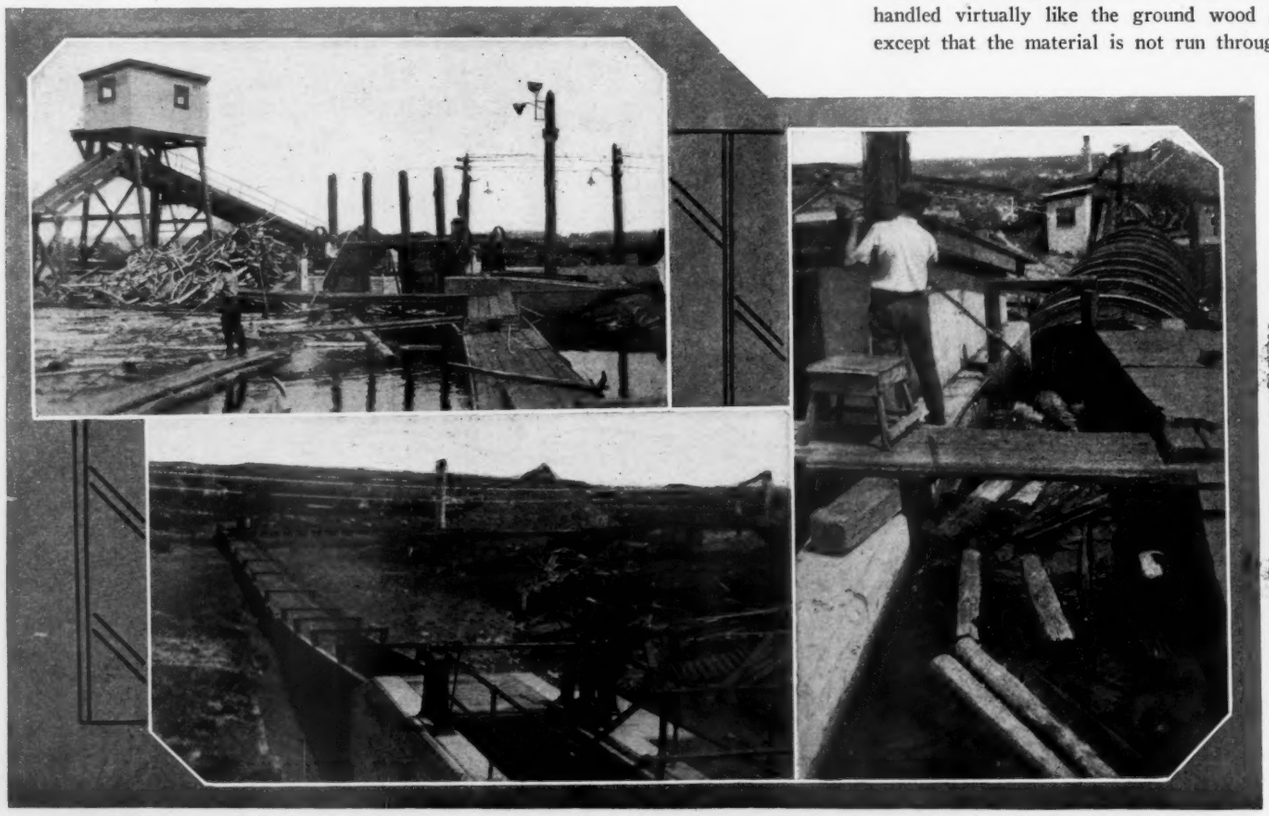


In the mill pond. Logs that have been floated down to the plant ready to be run through the barking drums before stacking or before going direct to the mill for treatment.

To load a digester, the heavy metal cover is unbolted and hoisted out of the way, after which a chute is opened in the bottom of the overlying bin and the chips are allowed to flow by gravity into the cavernous tank. When enough of the chips has entered the digester the chute is closed, the cover is replaced and sealed tight, and connections are made with the steam line and the relief line—the latter affording a way by which excess liquor and gas can escape from the digester during the cooking period. At Millinocket, the heating steam is brought immediately in contact with the charge, and this is what is known as the direct cooking process. The sulphurous acid is pumped into the digester from the bottom end; and not until a proper quantity of this has accumulated is live steam turned in from above. The chemical action of the acid in attacking the resins and lignin is somewhat complex and need not be dealt with here. For the present purpose all that need be said is that the combined effect of the steam heat and the acid is to free the wood fibers from the vegetable matter which normally surrounds them and binds them together.

When a charge has been cooked long enough it is ejected from the bottom of the digester and discharged into what is termed a blow pit. The blow pit is really a capacious wooden tank provided with a false bottom of perforated boards which facilitates draining off and washing out the acid in the sulphite pulp.

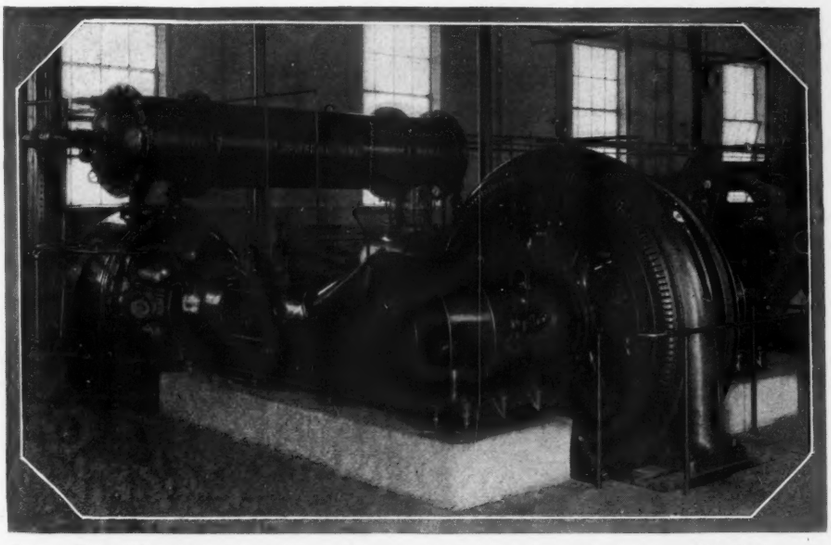
It is essential that the pulp be completely freed of all trace of acid if the subsequent paper is to be durable. The washing takes anywhere from one to two hours. When the sulphite pulp has been satisfactorily cleansed it is diluted with white water and is picked up by a centrifugal stock pump which sends it to the sulphite screening room, where the stuff is handled virtually like the ground wood pulp except that the material is not run through a



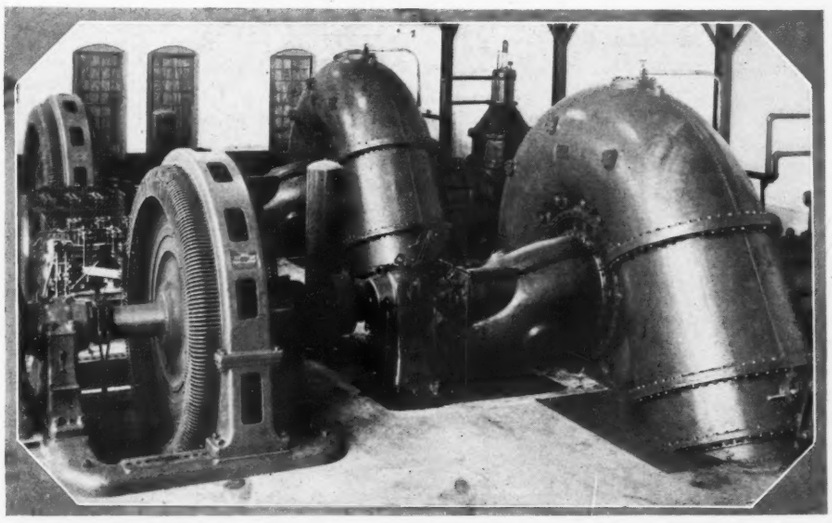
Top—Logs being fed from the mill pond down into the barking drums. Bottom—After leaving the barking drums the sticks shoot down a sluiceway either to the mechanical stackers or into the wood room of the mill. Right—Close-up of the sluiceway by which the logs are delivered to the barking drums.

riffler rack. After the pulp has been suitably screened it is sent to mechanical thickeners, and then, when of the right consistency, it is pumped to a big storage tank.

At this point it might be well to describe briefly how the sulphurous acid is made which is used in the sulphite process. This acid is manufactured at the mill from flowers of sulphur, and the main features of the procedure are as follows: The sulphur is first melted by steam heat and then fed to sulphur burners —slowly rotating horizontal cylinders—in which the mineral is converted into gas. This gas is passed successively through an air and a water cooler, both of which are formed of lead piping because a small amount of highly corrosive sulphuric-acid gas is produced. From the water cooler the gas is conducted to acid towers constructed of reinforced concrete and lined with acid-resisting tile or brick. In these towers is packed broken limestone supported by suitable grates; and the sulphur gases are blown upward through the limestone which absorbs some of them. Next, water is fed into the towers at their tops and, in descending, washes the limestone and takes up the contained acid. In this manner the water percolates through both towers and becomes sulphurous acid of ample strength to do the work expected of it in the digesters. The acid is stored in wooden tanks from which it is drawn off by a Cameron centrifugal pump, and delivered as needed to the digesters.

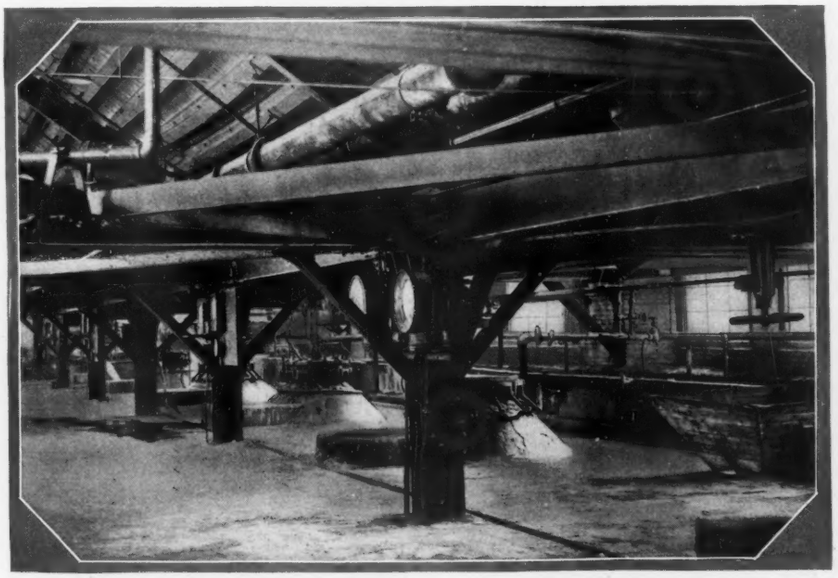


One of the large compressors that furnish motive air for a variety of purposes throughout the mill.



Generator room of the Millinocket mill where big waterwheels drive the dynamos which furnish electric current for numerous purposes throughout the plant.

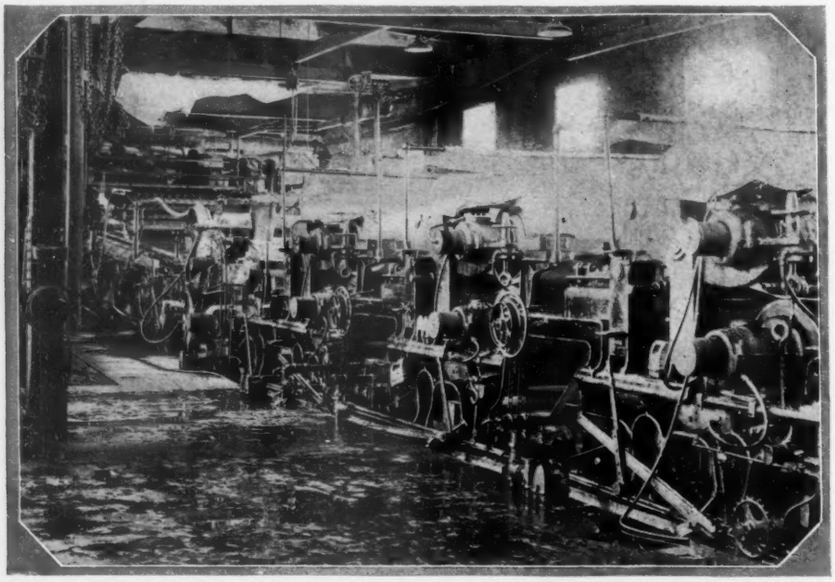
In the sulphite screening room are numerous wet machines, the purpose of which is to produce blanket-like folds or "laps" of pulp. In the making of a lap, fluid pulp is fed onto a felt belt and a film is gradually built up on this belt which is run between rolls and pressed, thus freeing the pulp of about 35 per cent. of its water content. When the sheet has acquired the desired thickness it is skilfully torn into suitable lengths by the operator and folded in the manner which explains the reason for the descriptive term. These laps may be stored for future use. Wood pulp in this form must first be mascerated in a beater or a mixer and turned again into fluid pulp before it can be fed to paper-making machines.



Charging floor of the digester room with the tops of some of the digesters visible to the right of the columns supporting the chip bin.

To combine the sulphite pulp and the ground wood pulp prescribed proportions of each are fed to beaters, vat-like machines, which thoroughly mix the pulps and combine with them alum, coloring matter, and finely pulverized white clay. The alum, which is really aluminum sulphate, acts as a sizing and helps to retain the clay in the paper. The function of the clay is that of a filler for the felted mass of the wood fibers. From the beaters the mixture passes through an apparatus which automatically regulates the consistency of the stuff by adding or by withholding white water. But before the stock is delivered to a paper-making machine it must journey through a vibrating screen. This screen is finer than any employed in the preparatory stages already described; and the object of the treatment is to remove all slivers, dirt, or other objectionable materials which may have got into the pulp in any way.

From the Bird screen, for such is the type used at Millinocket, the stock goes to a head or flow box fitted with a series of baffles; and,



Wet end of a Fourdrinier paper machine. Here it is that the highly fluid stock is converted into a soft pulpy film which represents the initial state of a sheet of newsprint.

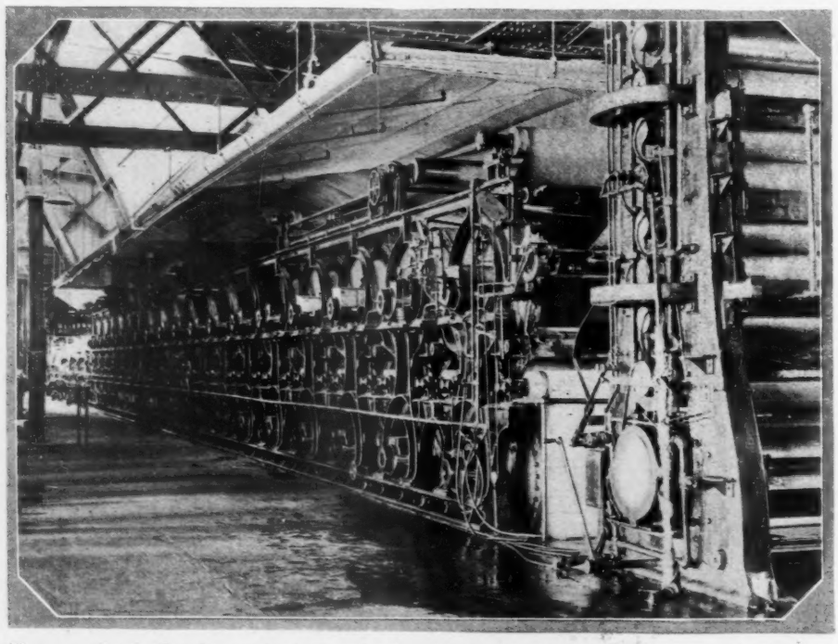
finally, it flows from what is termed the apron onto the "wire" of the paper-making machine. At this point, the pulp is subjected to a spray of white water to prevent the formation of foam. We are now about to describe the essential features of the Fourdrinier type of paper-making machine which has revolutionized the art.

The Fourdrinier wire is really an endless belt of wire mesh having from 60 to 70 copper or brass wires to the inch. As might be expected, the wire is stretched horizontally between two rolls and is pitched toward the second or lower roll. Thus suspended, the wire offers a make-up surface 20 or more feet long on which the pulp is spread uniformly at a speed equal to that of the downward and forward movement of the upper half of this metal-mesh belt. The speed of the belt is constant. The function of the wire is twofold: first, to offer a surface or table upon which the paper pulp can be distributed in a highly fluid condition, and, next, to facilitate the while the extraction of a considerable percentage of the water which has been necessary up to this point. The extraction of the water is effected both by gravity and by the action of suction boxes located crosswise beneath the wire and in contact with it. At the instant the pulp leaves the apron and is delivered to the wire the paper stock is about 96 per cent. water; and from there onward most of the other operations of the machine have to do with getting rid of all but about 10 per cent. of this moisture content.

While the pulp is on the wire, the latter is shaken laterally so that the flowing fibers are interwoven or felted, otherwise the fibers would all tend to flow parallel with the stream and the resultant paper would be comparatively weak. Along each edge of the wire there is a thick, adjustable, rubber belt, called the "deckle strap;" and these form marginal dams to confine the pulp and to regulate the width of the sheet.

When the porridge-like film reaches the lower end of the Fourdrinier wire it has sufficient consistency to hold together while being carried across a short gap onto what is called the couch roll, where it is picked up by a belt of woolen felt which supports it during a rapid journey between a series of press rolls. Compressed air is used to blow the forming paper from the couch roll onto the first of the press rolls. The press rolls compress the pulpy sheet; and on issuing from the last of these the paper contains 70 per cent. of moisture. The press rolls and the Fourdrinier wire constitute what is known as the wet end of the paper machine.

After going through the press rolls the paper is swept by compressed air onto the drier rolls, which are heated by exhaust steam, and is carried over them by supporting belts of cotton fabric several hundred feet long. On leaving the drier rolls the new sheet of paper is blown across to the calender stack, composed of a series of nine revolving steel rolls mounted one above another, and is similarly zig-zagged and interlaced between these rolls by jets of compressed air. Again, the paper is carried on a current of air from the last of the calender rolls to the reel upon which it is first wound. Finally, compressed air tears the sheet crosswise when enough paper has accumulated on the reel. Formerly, the forming sheet was laced by hand all the way through the machine from the couch roll to the last of the calender rolls. This was not especially hazardous until the speed of paper machines attained their present high rate. This greater speed has made it nearly impossible to carry over the paper by hand. The Pope Appliance Company carried on a great many experiments at this mill, where the first high-speed machine in this country was operated. The aim was to facilitate the handling of the paper, to reduce the "broke," and to eliminate the risk to human life and limb. Nozzles were designed, invented, and patented by the Pope Appliance Company, and these made it possible to use compressed air to decided advantage. The air for the preliminary experiments was furnished by a 16-inch stroke XPV-3 Ingersoll-Rand compressor. These appliances are now in general use in the United States and in Canada where higher speed machines are being used to increase production. The use of compressed air, therefore, not only saves time but it safeguards the workers. This cannot be fully understood until one has a chance to see a newsprint machine turning out a sheet of paper 146 inches wide, when trimmed, at the rate of 850 to 900 feet a minute throughout a 24-hour day.

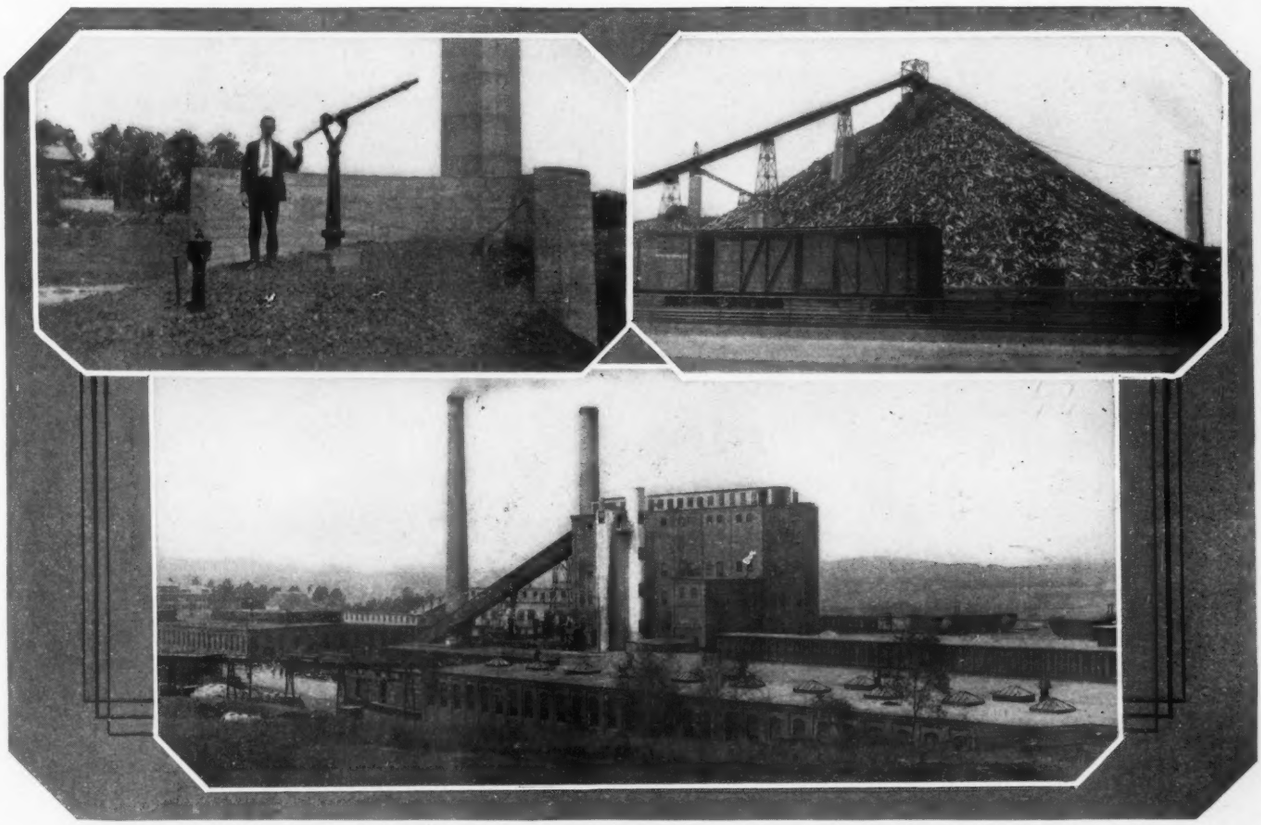


Here we have the dry end of a paper machine whereby the moisture is finally reduced to something like 10 per cent. when the sheet issues from the last of the calender rolls.

From the reel, the paper-laden roll is lifted by an air hoist and transferred to a winder where it is rewound for shipment—usually forming two finished rolls each 72 inches wide, after the edges have been trimmed, 18,900 feet long, and containing about 1,400 to 1,500 pounds of newsprint. The tough paper in which it is wrapped for shipment is a by-product of the waste incidental to the manufacture of newsprint.

Limited space forbids telling more about this splendid plant wherein are installed powerful Corliss engines to drive the paper machines, numerous waterwheels, and two turbines which actuate two alternating-current generators developing power to drive the auxiliary equipment. As might be expected, the employment of compressed air in many directions calls for the service of no fewer than three stationary compressors, the XPV-3 already mentioned, a PRE-2, and an old "JC" which has been operating continuously for over 20 years—all of which are capable of producing the equivalent of nearly 3,000 cubic feet of free air per minute. This air is distributed throughout the plant at a working pressure of 80 pounds.

Aside from the uses already mentioned, compressed air is utilized for cleaning the paper machines; for cleaning electric motors; for spray painting; for operating an air lift in pumping water from a deep well; for working a cement gun; and for driving various pneumatic tools which do riveting, rivet busting, calking and chipping, and drilling concrete. Beyond the range of the air lines fed by the stationary compressors in the mill, the company relies upon an 8x8-inch portable compressor. This machine furnishes air for guniting, for operating "Jackhamers" when drilling rock, and for driving pneumatic tools for outlying undertakings calling for the employment of structural steel or the remodeling or repair of concrete. Enough, undoubtedly, has been said to show that compressed air is a valuable, if not an indispensable, source of energy in the efficient running and up-keep of a modern paper plant.



Left—To guard against fire, each wood pile is wetted daily by means of eight pivoted nozzles mounted behind concrete shields. Right—One of the two storage piles of pulp wood. Each contains a maximum of 40,000 cords. Bottom—How the mill at Millinocket appears when viewed from a near-by hill on the premises.

SALT TREATMENT TO LESSEN MINER'S FATIGUE

THE following brief abstract from a paper read by Sir Josiah Court before the Institution of Mining Engineers should prove of interest as it relates to a subject deserving of careful consideration and investigation. It has been observed that men working in hot mines suffer from fatigue with occasional attacks of cramps. Dr. J. S. Haldane, the eminent British physician and man of research, suggested that the cramps might be due to excessive loss of sodium chloride by reason of profuse sweating, and it was therefore decided to see what effect the drinking of a weak solution of salt in water would have on miners at work.

A number of experiments were recounted, but one of them will suffice for our purpose. Six miners, coming straight from the pit shaft, were interviewed; and the temperature of the air in the stalls where they operated varied from 79° to 81° F. Each collier took down daily a tin can containing four pints of water, all of which he drank while working at the face. Salt was added in the proportion of one teaspoonful to a quart of water. The results have been most gratifying. The six miners began to take salt in their drinking water on April 4, 1924. After a month's trial they all claimed they were less tired after their work; one man asserted that he no longer wanted his usual nap when he got home; and a third said that cramps in his leg did not trouble him any more.

Experiments were also made with men stoking the boilers for a colliery pit and working in a temperature of 96° F. They added half a teaspoonful to a quart of water, drinking usually four pints per day. Each man was pleased with the outcome, and reported feeling less fatigued at quitting time.

To maintain Hamburg's position in the shipping world, plans are underway to increase her dock and harbor facilities, in short, to make the port equal to the best in Europe.

Mementos of a Vacation Spent in the Cascade Mountains in Our Great Northwest

Here we have picturesque vistas of woodland roads, tumbling waters, babbling streams, and the snow-clad shoulders of towering mountain peaks that have been made accessible to the Nature-loving tourist largely by reason of splendid highways—highways in large part made possible through the agencies of portable compressors and air-driven rock drills.

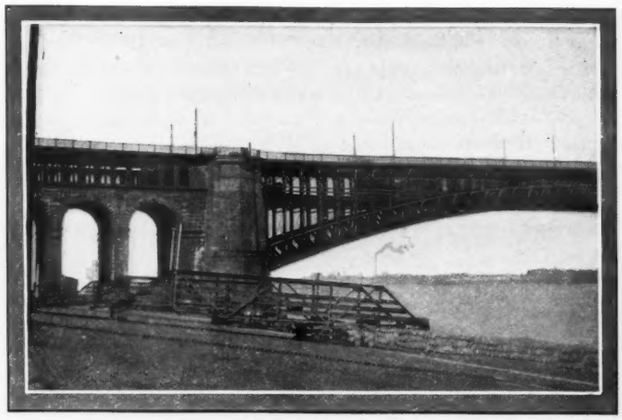
These photographs were taken by one of our valued contributors, Mr. Charles W. Melcher of Chicago, who spent part of last summer covering the trails leading to beautiful Lake Chelan and Mt. Rainier in the Cascade Range of our great Northwest. It is easy to understand why he has wished the readers of the Magazine to share with him some of the wonders of regions where Nature has done with a lavish hand everything calculated to appeal to man's sense of beauty and appreciation of rugged grandeur.

Eads Bridge A Monument To Compressed Air

By THE STAFF

SO MUCH is now done by means of compressed air—in fact could hardly be done without it—that we are all too apt to lose sight of some of the milestones that mark the road we have traveled thus far.

One of the most significant of these milestones is the justly famous Eads Bridge which links the Illinois and the Missouri shores at St. Louis. That the structure entailed an outlay of $10,000,000 and took years to build are facts that tell only a small part of the story, as viewed from an engineering standpoint. What is far more important is that James B. Eads had the courage to break away from hampering precedents and dared to employ compressed air upon a scale previously undreamed of in order to carry certain of the supporting piers down to solid rock far below the normal surface of the fickle and, at times, tumultuous Mississippi.



West end of the famous Eads Bridge.

Without entering into the structural details of this great bridge, let it be said that the three river spans rest in the main upon massive piers which stand directly in the path of the stream. The middle span has a spread of 515 feet in the clear, and is jointed to two other spans each of which is 497 feet long. Upon these spans are carried steam railroad tracks, and above the tracks there is an open deck, 50 feet wide, having footwalks and a roadway for vehicular and trolley-car traffic.

Before the days of the Eads Bridge, trains had to be broken up in reaching either shore and were then ferried across in sections. Flood waters, ice, and fogs severely handicapped this service at times; and the lack of a bridge was a heavy drag upon industry and the transportation of passengers and freight to and from the expanding Southwest.

The planning of the structure took years, because the magnitude of the undertaking and the physical conditions gave rise to many puzzling problems that could not be solved by reference to work done on other bridges. A prerequisite was that the underside of the central arch should be high enough to permit existing river craft to pass safely beneath it at all stages of the water; but the most difficult task was that of devising means by which the pier foundations could be set upon rock lying fully 96 feet below the normal surface of the Mississippi. To sink the foundations meant descending through 14 feet of water and 82 feet of sand; and, in the case of the largest pier, called for an enveloping caisson 114 feet high and of 86 feet internal diameter. No caisson of anything like kindred dimensions had been used before or had been sunk to such a depth. Scores of reputable engineers were frankly skeptical and were outspoken in their belief that Mr. Eads would fail if he tried to execute his plans.

Indeed, Mr. Eads had his own doubts, and that he waivered is evidenced by a report he made during the formative stages of the scheme. As he expressed it: "The shortness of the season in which one of the piers for the bridge must be put in position, because of the floods of summer and the ice of winter, and the great amount of deposit to be removed, render the pneumatic process . . . too slow for this case, as well as too expensive. For the safety of the workmen beneath the pier, it is absolutely necessary to regulate its descent by screws or similar means, and to do this with piers of such magnitude would not be advisable."

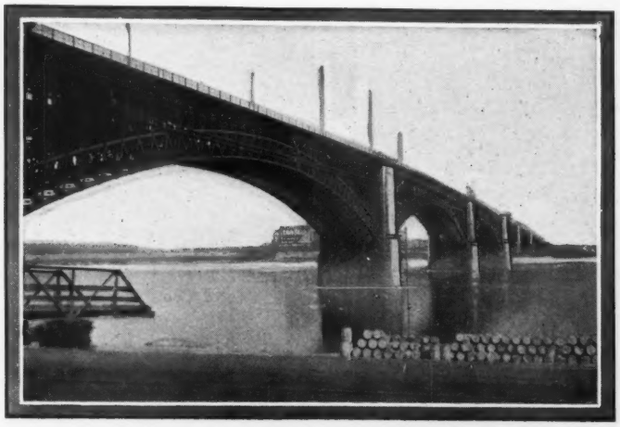
Failing health took Mr. Eads abroad in 1868, and while convalescing he conferred with numerous foreign engineers. As a result, when he returned to America, he determined to resort to the compressed air method to get his caissons down to solid rock—having convinced himself that that procedure would be less costly and more expeditious than any other.

On October 17, 1869, the big caisson for the east pier was launched at Carondelet, immediately towed to its intended position, and sinking started. In the forenoon of February 28, following, the shrieking of steam whistles and the thunder of cannon proclaimed that the caisson had come to rest on bedrock. But this had not been achieved without setbacks.

At times the ice in the river kept the workers on the caisson isolated for days. They had to eat, toil, and sleep on their artificial island in the middle of the forbidding stream. When the caisson reached a depth of 66 feet in its downward journey a telegraph instrument was placed in the air chamber and a wire led to one of the attending derrick boats and thence to Mr. Eads' office in St. Louis. In this way the men in the working chamber and those outside of it were kept in communication.

For the purpose of carrying the excavated sand surfaceward, Mr. Eads devised a pump, but its operation at first caused a good deal of trouble and invited disaster. While drawing in sand the pump also sucked out air, and the latter action lowered considerably the air pressure in the working chamber. The drop in pressure caused the remaining air to expand and to absorb heat—thus reducing the general temperature. As a consequence, the chamber became so filled with foggy vapor that the men could see to work only with much difficulty. But this was not the most serious effect.

As explained by Prof. C. M. Woodward in his book on the St. Louis Bridge—as the structure was first called: "The diminished pressure caused water against the outer walls to force its way down and under the cutting-edge, gradually washing the sand from under the outer sills, while the sand remained intact under the central walls." That threatened to break the backbone, so to speak, of the caisson by overloading it. The trouble was subsequently overcome by shoveling the sand into a box; by stirring the sand with a stream of water; and by seeing to it that the pump intake—which was run to the box—was kept continually submerged. It is said that the friction in the discharge line, caused by the rapidly moving gravel and sand, was so great that the stream of air and sand produced a "semi-luminous



Eads Bridge from the St. Louis shore.

flame" visible at night to people on the opposite side of the river.

When the first of the caissons was sunk but little was known of the physical effects of compressed air upon workers. Where compressed air had previously been employed by European engineers their observations had been almost entirely limited to noting the action of increased air pressure upon the ear. Therefore, the building of the Eads Bridge may properly be said to have focused attention upon the general physiological effects of compressed air and, in a measure, to have been the means of bringing to light ways by which caisson disease might be combated and prevented. This knowledge cost dearly, for no fewer than 119 cases of bends, etc., occurred among the "submarines"—as the caisson workers were then called; and out of that number 14 died and 2 were known to have been permanently crippled.

Pioneer research in this field was done by Dr. A. Jaminet, of St. Louis, who exposed himself repeatedly to heavy pressure in the caissons and suffered temporary disability. Doctor Jaminet's investigations revealed the existence of congestions in the brain, spinal cord, etc., which he attributed to the expansion of gases, in the blood, when pressure was released. His conclusions were afterwards confirmed by other investigators who, following in Doctor Jaminet's footsteps, devised means by which the deep sinking of foundations could be robbed of well-nigh all bodily menace so far as concerns the physical effects of compressed air.

It is interesting to mention here that two steel bridges of more modern design now span the Mississippi at St. Louis both north and south of the Eads Bridge; but their speedy and successful building was no doubt helped largely by what was learned while using compressed air on the monumental structure which was finished in 1874.

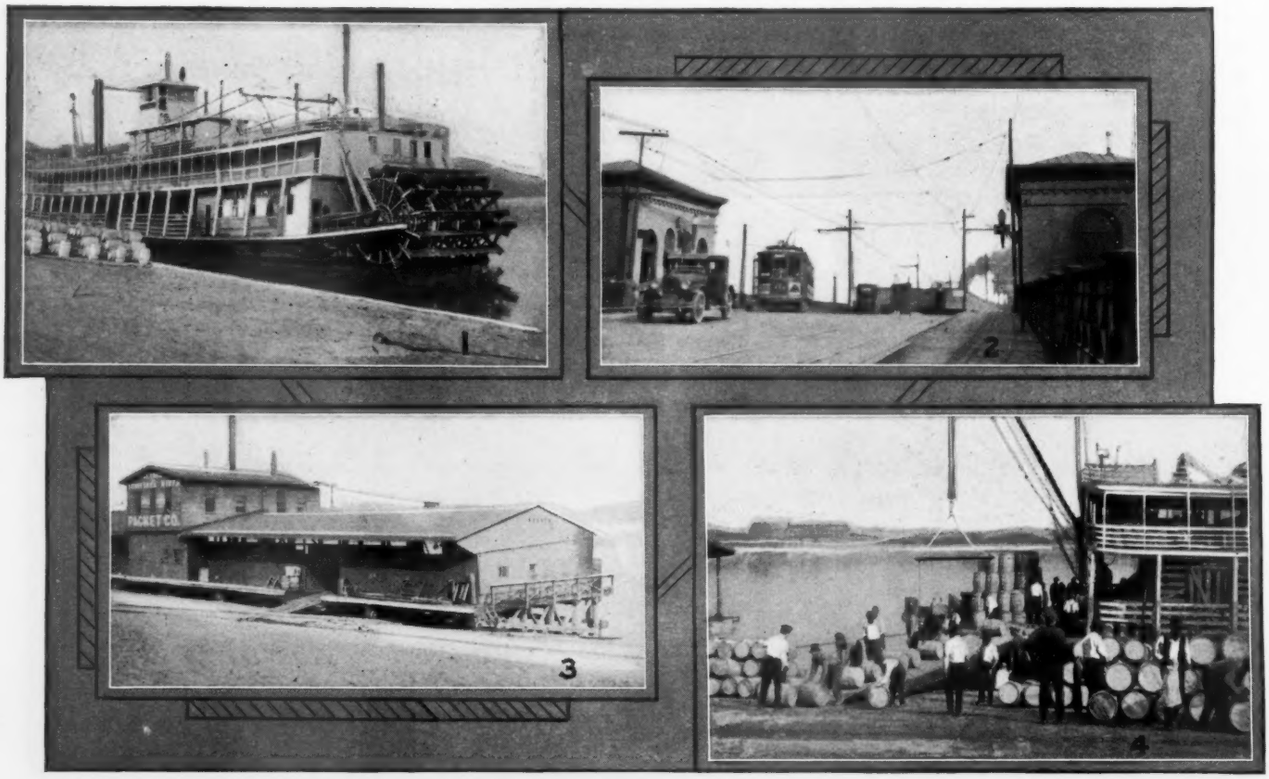


Fig. 1—Stern-wheel steamers still ply the Mississippi River.
Fig. 2—East end of the main section of the Eads Bridge.
Fig. 3—Freight house on wheels which, in turn, rest on rails that run down to the waterfront. This permits the structure to be pulled up and out of harm's way during flood periods.
Fig. 4—Unloading freight from a river steamer at St. Louis.

GREAT OCEAN DEPTHS

THE deepest place so far discovered in any ocean, according to the United States Geological Survey, is located about 50 miles from the coast of Japan in the Pacific. A Japanese man-of-war, the *Manchu*, found the spot recently while on a chart-making expedition. The depth is so great that it could not be measured for the reason that the sounding wire carried by the vessel had a reach of but 32,644 feet, or nearly 6¼ miles. How much deeper the ocean may be at this point is at present a matter for speculation.

The greatest ocean depth previously known was discovered by a German surveying ship, in 1912, off the coast of Mindanao, Philippine Islands, where bottom was touched at a depth of 32,113 feet. These great depths have lately become of interest in connection with the study of earthquakes that appear to be produced by the slipping of strata along planes way down in the crust of the earth. In the Atlantic Ocean the deepest place so far found lies just east of the Island of Haiti, where the bottom lies 27,922 feet below the surface. This great "deep" is also in an area that is shaken by earthquakes.

The new sonic sounding apparatus—an American invention that measures depths by recording the time required for sound waves to travel to the ocean's bottom and to return—will facilitate the work of determining great depths of water. This apparatus gives a new significance to the word "sounding."

The British government is spending about $40,000,000 in reconstructing its main roads throughout the country; and the Ministry of Transport has appointed a committee to investigate the slipperiness of certain types of highways. The Great North Road is said to be dangerously slippery after a rain or even heavy dew. The surface is shown to be too rich in bitumen; and it has been decided to recoat sections of the road with a poorer grade of bitumen and with as much granite chippings as the material will absorb. As this is not regarded altogether satisfactory, further investigations and experiments are in progress.

Compressed Air Doubles Production of Granite Quarry

North Carolina Has Used Over Three Million Tons of Crushed Stone for Roadbuilding Within the Past Three Years

By E. H. PAULL

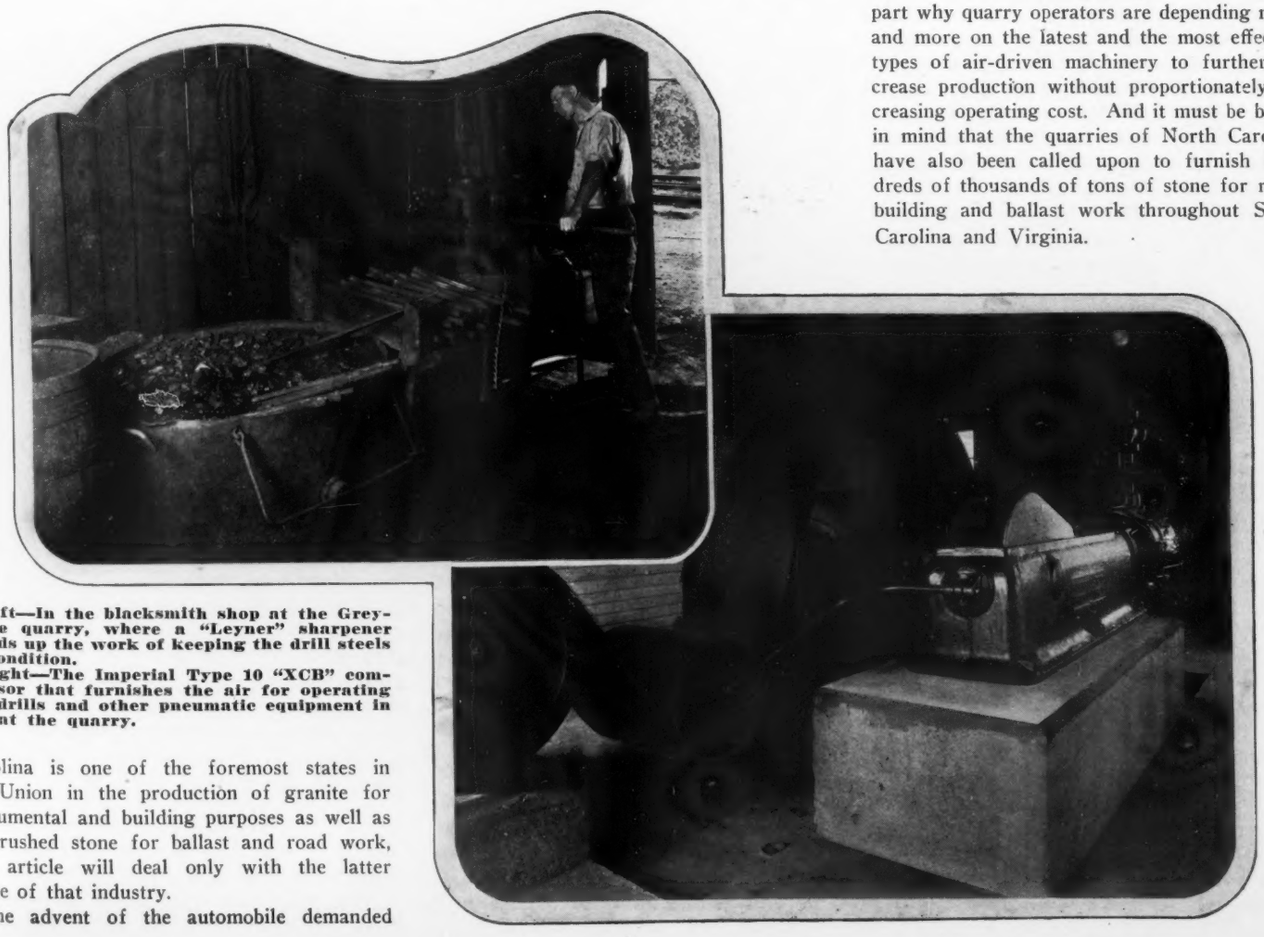
GRANITE is the most common, the most durable, and the most used of all igneous rocks, and is often referred to as the "rock of ages." It rightly deserves this name, as it forms the backbone of most of our mountain ranges and has defied Mother Nature's weathering action for centuries. Wind, rain, heat, cold, and other erosive agencies have worked unceasingly since the beginning of time to disintegrate these massive rock formations; but granite has stood the test and thus proved its wonderful resisting and wearing qualities. These, together with its hardness, make it the choice of roadbuilding materials. It is not surprising, therefore, that granite should play an important part in the gigantic roadbuilding program of North Carolina.

In view of this fact, North Carolina is fortunate in being rich in rock formations of this sort. These are not confined to any one area but are fairly widespread throughout the eastern and the central portions of the state, as exemplified by the numerous granite quarries in operation there. While North Carolina is one of the foremost states in the Union in the production of granite for monumental and building purposes as well as of crushed stone for ballast and road work, this article will deal only with the latter phase of that industry.

The advent of the automobile demanded more and better roads. This has been especially true of the past ten years, or since the day the motor-driven vehicle reached a stage where it became a necessity in the business world, aside from its use for pleasurable purposes. The authorities of North Carolina were not slow to appreciate the value of good roads and to recognize that the available sources of suitable building materials would be of advantage in improving the state's highways. The great quantities of granite within reach simplified the problem; and, in 1921, the General Assembly took its first step, that is, its first big step, in constructing roads on what might be called a quantity basis and of a quality second to none.

To build and to maintain the roads of North Carolina, the General Assembly authorized a big bond issue for highway development. In other words, within the past three years there has been invested over $76,000,000 for that purpose. Of this sum, $11,000,000 was appropriated by the Federal Aid and by different counties in the state. This debt was the largest ever incurred by the state since its organization. Prior to the great plunge, statistics show 132 years of extremely conservative history. That the investment of $50,000,000 in 1921 proved a success, is brought out by a second venture. At a meeting in 1923, the General Assembly in less than an hour's discussion voted an additional sum of $15,000,000. And let it be said that the greater part of that discussion was spent in debating whether or not the amount involved was sufficient for the work to be done. Recent reports show that the outlay has already yielded generous returns.

The benefits derived from the expenditures are now being reaped not alone by the residents of North Carolina but by those of neighboring states, and by motorists from near and far. A person has but to drive over the far-reaching highways of North Carolina in order to understand why the crushed-rock quarries of the state have been worked to capacity during the past few years, why they have turned out millions of tons of the commodity. This ever-growing demand for crushed stone for roadbuilding purposes explains in part why quarry operators are depending more and more on the latest and the most effective types of air-driven machinery to further increase production without proportionately increasing operating cost. And it must be borne in mind that the quarries of North Carolina have also been called upon to furnish hundreds of thousands of tons of stone for roadbuilding and ballast work throughout South Carolina and Virginia.



Left—In the blacksmith shop at the Greystone quarry, where a "Leyner" sharpener speeds up the work of keeping the drill steels in condition.

Right—The Imperial Type 10 "XCB" compressor that furnishes the air for operating the drills and other pneumatic equipment in use at the quarry.

With the huge bankroll at their disposal, the State Highway Commission of North Carolina built 3,682 miles of road. Of these, 1,448 miles were paved, while the remaining 2,234 miles were made up of roads of various sorts. To turn these into the kind of highways that we are accustomed to today, the commission bought 86,800 carloads of crushed stone, 44,784 carloads of sand, and 21,720 carloads of cement, or approximately 5,818,160 tons of roadbuilding materials. We can more readily grasp the magnitude of the undertaking when we are told that it would take a train reaching from Portland, Me., to beyond Kansas City, Mo.—a distance of 1,597 miles, to carry these materials.

The use of compressed air in carrying out this roadbuilding program cannot be overlooked, for it plays an all-important part in the quarrying of the granite rock, not to mention the work performed by it in roadbuiiding, itself. A few years ago the increased demand for crushed stone was met by adding to the number of drills in service at a quarry. Drilling was then done by the old piston type of steam-operated drill. While this method augmented production it likewised increased operating expenses. About two years ago a pneumatic drill of the hammer type, striking from 1,600 to 2,400 blows per minute, was placed on the market and started a new era in the field of quarrying. This air-driven drill has almost entirely replaced the piston type of drill for quarry work, with a resulting increase of from 50 to 400 per cent. in drilling speed and in production.

While local conditions may differ somewhat, most stone quarries, whether they be in the North or the South, are generally operated along similar lines. Therefore, a description of the activities at the Greystone plant of the Raleigh Granite Company of North Carolina will give a good idea of how the stone is taken out. The quarry is located at Greystone, a station on the Seaboard Air Line Railway, and is four miles north of Henderson, the county seat. It is one of the oldest and largest workings in the state, and is now devoted entirely to the production of crushed stone. The property was formerly referred to as the Old Greystone Quarry. It was then owned by P. Linehan & Sons, who started operations about 1886. They carried on successfully for 30 years, taking out dimensioned stone, building blocks, and crushed stone.

In 1916, the property was taken over by the Raleigh Granite Company, with Mr. R. G. Lassiter, president; Mr. W. T. Ragland, vice-president and general manager; and Mr. H. B. St. Lawrence, superintendent. Since that time, as we have previously mentioned, the quarry has specialized in turning out crushed stone and is, from the standpoint of production, the largest crushed stone quarry in the state. Until the beginning of 1924, the output of crushed stone was anywhere from 400 to 500 tons per day. Then, however, the management substituted air-operated hammer drills for the steam piston drills in service. During the latter part of May more improvements were made: the entire steam plant was replaced by an electric plant. In consequence, under normal conditions, the company is now able to produce from 800 to 1,000 tons per day. In other words, the changes have brought about an increase in output amounting to 100 per cent.

When piston drills were employed, an aver-

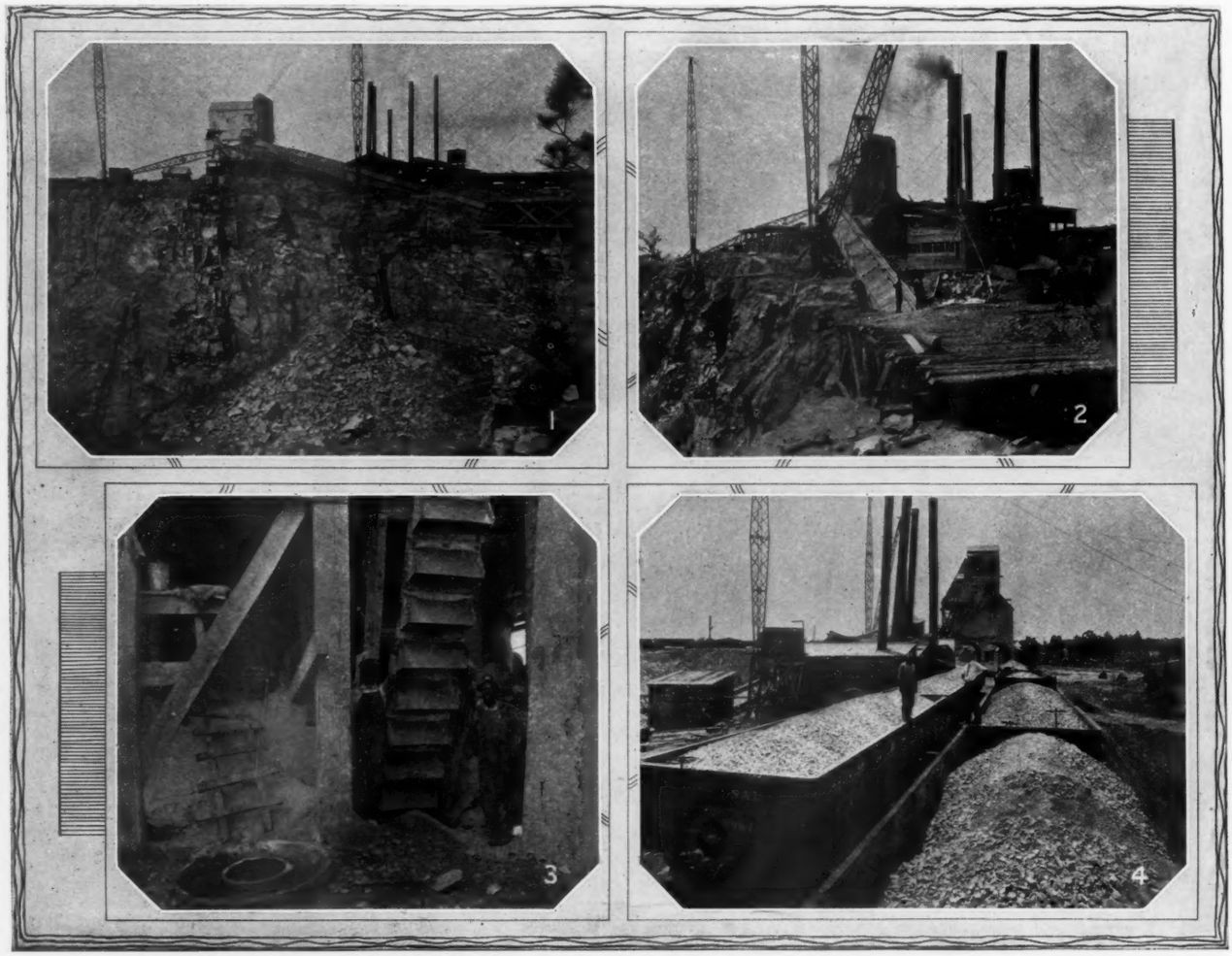


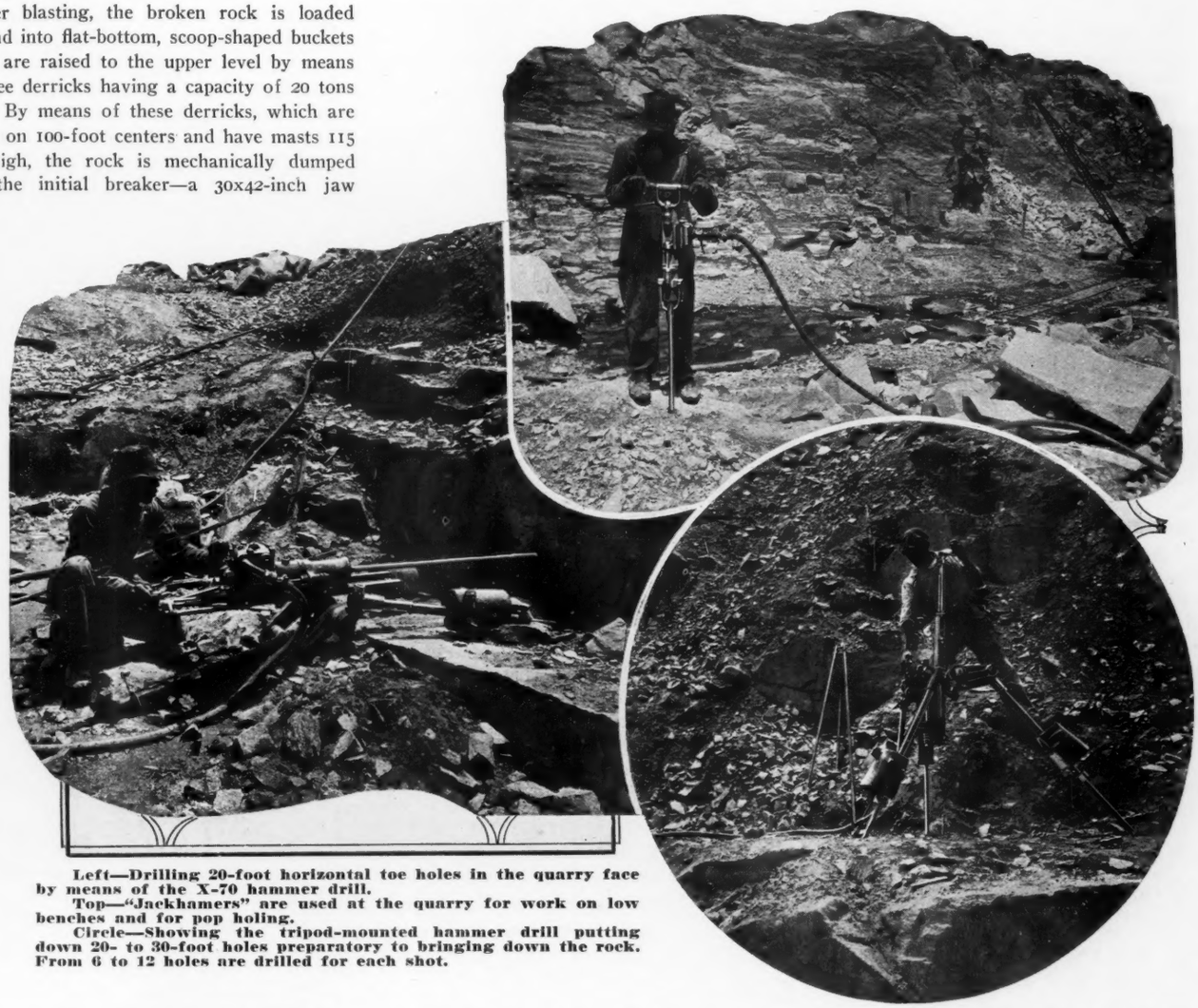
Fig. 1—General view of the crushing plant at the Greystone quarry. From the initial crusher beneath the platform, at the right, the broken stone is carried up to the crushing tower by an endless belt conveyer. Fig. 2—Another view of the crushing plant, showing two of the large derricks that deliver the rock as it comes from the quarry face to the initial crusher. Note the scoop in the foreground in the act of dumping its load. Fig. 3—By means of this bucket conveyer the stone is carried from the crushing tower to screens for grading. Fig 4—Cars loaded with the finished product ready for shipment to distant points.

age daily footage was made of from 20 to 30 feet per drill, whereas with an Ingersoll-Rand X-70 it is now possible to drill from 70 to 90 feet per 8-hour shift. At the quarry in question, these hammer drills are mounted on tripods; and holes 20 to 30 feet in depth are put down on 10-foot centers and 15 feet back from the face. From 6 to 12 holes are drilled for each shot. Well drills are used for sinking 50-foot holes, while "Jackhamers" serve to drill shallow holes and to do the pop holing necessary to break up the large boulders resulting from firing deep holes.

After blasting, the broken rock is loaded by hand into flat-bottom, scoop-shaped buckets which are raised to the upper level by means of three derricks having a capacity of 20 tons each. By means of these derricks, which are placed on 100-foot centers and have masts 115 feet high, the rock is mechanically dumped into the initial breaker—a 30x42-inch jaw crusher manufactured by the Farrell Foundry & Machinery Company. From the initial breaker the stone is carried on a 36-inch belt conveyer to the crushing tower where it passes through two No. 7½ McCully crushers and one No. 6 Worthington crusher. The rock, which is now ready for grading, is thence taken in bucket conveyers to 60-inch roller-driven screens, each 32 feet in length. These screens are of ⅝-inch, 1¼-inch, and 2½-inch mesh, and are manufactured by the Good Roads Machinery Company. After screening, the stone is stored according to size in separate bins, from which it is loaded into flat cars for shipment to all parts of both North and South Carolina as well as to the State of Virginia.

With the recent plant improvements, the Greystone Quarry Company expects to produce 175,000 tons of crushed stone this year, and an even greater output is looked for in 1925. In this connection it might be of interest to bring out just what progress has been made in the state in the actual work of building roads. According to Mr. Frank Page, Highway Commissioner of North Carolina, "In 1921 the completion of three miles of road in one month was regarded as an epochal event. . . . Next month (July, 1924) we will be turning out 100 miles of completed paving in 30 days, and a somewhat longer mileage of gravel, topsoil and other types of road."

It is no wonder then, taking into account the speed with which the work is now being done and the amount of roadbuilding going on, that the quarryman was forced to increase his output of crushed stone. To this end, it was only logical that he should turn to compressed air equipment, which has enabled him to place production on a footing commensurate with the demand.



Left—Drilling 20-foot horizontal toe holes in the quarry face by means of the X-70 hammer drill.
Top—"Jackhamers" are used at the quarry for work on low benches and for pop holing.
Circle—Showing the tripod-mounted hammer drill putting down 20- to 30-foot holes preparatory to bringing down the rock. From 6 to 12 holes are drilled for each shot.

SUGAR FROM CORN

IT IS announced that H. C. Gore, of the United States Bureau of Chemistry, has found a way to get 33 pounds of sugar from a bushel of corn, which is more than half the weight of the latter. The conversion of starch into sugar is no new discovery, but it is understood that a new method has been developed. This consists of mixing the cornstarch with warm water and malt and then putting it through the same processes as sugar cane, etc.

White, granulated sugar is called sucrose: other varieties are known as glucose and maltose. The latter, produced from corn, is somewhat sweeter than glucose but only about three-fifths as sweet as sucrose. Mr. Gore states that his discovery will tend to make us less dependent on foreign countries for our sugar supply and, when brought to a commercial stage, will furnish another outlet for our corn.

It may sound incredible, but we are authoritatively informed that about 4,000 earthquakes are felt each year in different parts of the world.

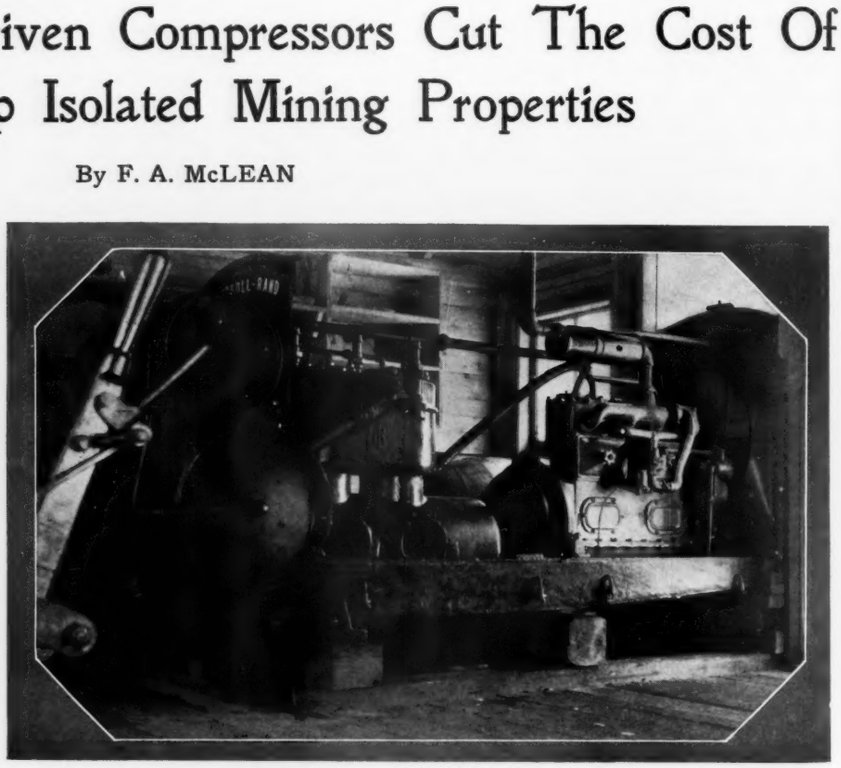
Portable Gasoline-Driven Compressors Cut The Cost Of Opening Up Isolated Mining Properties

By F. A. McLEAN

GIVEN a promising claim and the necessary financial backing to develop it, the first problem that usually confronts the mine operator is the selection of the necessary compressed air plant. The size and the kind of drive are questions that naturally follow, the former being determined largely by the amount of money available and the speed with which it is desired to carry on the program of development. The type of drive, whether it be an electric motor, steam, or oil engine, depends on local conditions and has an important bearing on the cost of operation.

Few prospective mine operators are fortunate enough to locate claims within the immediate radius of electric power lines, although this is more likely to happen nowadays than it once was. In the majority of cases, however, some other form of prime mover is necessary. Where wood or coal is available at moderate cost, a small steam-driven plant is usually chosen. Such plants are often arranged so that they can be converted to electric drive should future developments make this desirable. Many such installations are to be found in mines in northern Ontario. But at points where wood or coal is costly, or too hard to transport, oil-engine driven mining plants have many advantages in their favor and are now commonly used. In some localities oil is considerably cheaper than wood or coal and is much easier to haul over bad roads.

Both steam and oil-driven plants, however, represent a fairly large investment at the start and also require the erection of foundations and buildings wherein to house them. Should the property subsequently prove of little or no value, either plant must be torn down before it can be moved or sold; and additional expense is incurred in setting it up again at a new location.



This 9x8-inch, Type Twenty portable saw some rough going over fourteen miles of very bad roads before it was installed in the compressor house shown in another illustration.

When there is any doubt as to the ultimate value of a prospect, a portable, gasoline-driven compressor would seem to be the logical equipment to select as it is moderate in first cost and easy to transport. The earlier compressors of this type did not have the necessary strength and reliability for this class of service. But within the past few years they have been greatly improved; and the successful record they have made for themselves on construction work has led to their adoption for trenching, shaft sinking, tunneling, and other operations essential to the development of prospects.

Portable, gasoline-driven units are of particular value for several reasons in opening up prospects in localities remote from railroads and power lines. First, they can be transported without much trouble over rough country; will stand up under hard service; and are ready to go to work on arrival. Second, they are self-contained: they do not require boilers, pumps, or other auxiliaries. Third, the fuel compares favorably with coal or wood, is as a rule readily obtainable, and is easy to carry. Fourth, the first cost is moderate, and no expense or loss of time is involved in building and in subsequently tearing down foundations or housings. Should conditions make it advisable to move the power plant about the property or to another claim, this can be done more readily in the case of a portable compressor than with the average small stationary plant. To go back again to the question of haulage, as there are no auxiliaries to bother with, the portable can be taken into a claim long before the roads would permit the transportation of a permanent steam or oil-driven plant.

Now let us consider what the modern portable compressor has done in actual practice. To this end, we will begin by describing the work being done by the Manley O'Reilly Gold Mines, Ltd., in opening up a gold prospect in northern Ontario. The property is situated

Compressor plant and head frame at the Manley O'Reilly Gold Mines, Ltd., operating in northern Ontario. The compressor and the hoist are housed to protect them against storms and heavy snow falls. A, hood over radiator; B, radiator on compressor; C, head frame; and D, gasoline drum.

fourteen miles from the railroad station at Boston Creek and is reached by very bad roads. Due to the scarcity of timber in the districts, to the high price of coal, and to the difficulty encountered in hauling bulky fuels and heavy machinery, it was decided to employ an Ingersoll-Rand 9x8-inch Type Twenty, portable, gasoline-driven compressor. The rest of the plant includes a 6x8-inch "Circo" hoist, two "Jackhamers" fitted with chucks to take 1-inch hollow hexagon steels with 1x4¼-inch shanks, one hand shanking device, the necessary blacksmith's tools, hose, etc. This equipment was purchased in February, 1924, and was delivered at the property before the spring break-up. It was put in service in April, and has been running steadily ever since.

The excellent results obtained with this plant are clearly shown in an accompanying table. In commenting on the performance, Mr. W. J. Manley—the manager of the property, to whom we are indebted for the figures—said: "We sank 62 feet in 30 shifts of 8 hours each. It took 5 hours to drill off the round, which I consider particularly good as the formation is red porphyry, a very hard rock. Eighteen holes, with an average depth of 6 feet each, were drilled in that time and about 5 feet shot at each round. The cost of repairs to compressor and drills has been nil.

TABLE OF PROGRESS AND COSTS FOR MAY, 1924.

MANLEY O'REILLY GOLD MINES, LTD.

Number of 8-hour shifts	30
Number of holes per round	18
Average depth of hole	6 ft.
Average total footage per shift all holes	108 ft.
Total depth sunk	62 ft.
Total footage all holes drilled	3,240 ft.
Fuel consumption	350 gals.
*Total cost of fuel, at $0.39 a gal.	$136.50
Cost of fuel per foot of hole	$.0105
Cost of fuel per 8-hour shift, 11⅔ gals.	$4.55
Time required to drill a round	5 hrs.
Fuel consumption per hour	2⅓ gals.
Approximate fuel cost per foot of shaft	$2.21

*About 75 per cent. of the total fuel cost is chargeable to hoisting.

A mobile plant—a 9x8-inch portable compressor—provides the air required to drive this drifter in a Canadian mine.

"Gasoline costs us $17.05 per 44-gallon drum laid down at the property. Six drums are a load; and one trip for each team is considered a day's work. During the 30 shifts mentioned we consumed 350 gallons of gasoline. This seems very good. We have had no trouble in maintaining a pressure of 90 pounds when running the two DDRW-13 drills, and have not yet opened up the compressor to full capacity."

The double-cylinder, single-drum hoist used for mucking is operated by compressed air. Anywhere from 1½ to 2 days are spent in removing the spoils after each shot and, besides, three hours of each shift in which a round is drilled and blasted is also devoted to mucking. A fact worth mentioning in connection with this property is that only one man is required to look after the entire plant. Where a steam-driven compressor is used, as is the case with the average prospect, it is usually necessary to have one man to fire the boiler and another to run the compressor and the hoist.

The foregoing clearly brings out the value of portable compressors for shaft sinking on isolated properties. Now let us see what results have been obtained in tunnel driving. The Crystal Copper Company of Marysville, Mont., took over a partly developed property in the early part of 1922, and wished to extend a tunnel which had been driven for a distance of 628 feet before operations were abandoned. According to the managing director of the company, "To install electric lines or a steam plant would have been expensive and taken time that we did not want to let pass. To get underway quickly and to have power for any emergency that might arise during the winter we installed an 8x8-inch portable gasoline-driven compressor and a Leynor-Ingersoll drifter. This drill required about half the output of the compressor so that we could operate another drifter or stoper, if desired. We used the compressor about 20 hours out of the 24 and worked two

Stoping with a "Jackhamer" in a gold mine where the operating air is furnished by a portable compressor.

shifts, of two men each, in ground much harder than that usually encountered in mine tunnels. By January 29, we had driven 75 feet in 18 days—an advance of 1.04 feet per man per day, or over four times the speed of hand work in the same tunnel. The compressor worked smoothly, giving no trouble, and required but little attention."

According to a later report on the same job, "Badger Tunnel on the Penobscot properties is being driven ahead at an average rate of 6 feet a day. At this rate the company hopes to be in pay ore by the end of the month. Previous work in the tunnel was by contract, skilled miners doing the work with hand steels. They were able to drive 50 feet in 206 working days, or an average of a little less than ¼ foot per day per man as compared with an average of 1.45 feet per day per man with the machine equipment." The actual cost of this work is as follows:

Mine labor, per foot	$2.71
Gasoline for power, per foot	1.83
Blacksmithing, hauling powder, gasoline, coal, etc.	1.67
Powder, per foot	1.60
Fuse, per foot	.163
Caps, per foot	.05
Carbide for lamps, per foot	.04
Coal for blacksmith shop, per foot	.057
Total cost per foot of tunnel	$8.120

Excellent results in driving a 5x5-foot drift in hard rock on a gold prospect are also reported by the Independence Gold Mining Company, of Stewart, B. C. The compressor, a 5x5-inch Ingersoll-Rand gasoline-driven portable, was transported early this spring over roads covered with fifteen feet of snow. It supplies air for a "Jackhamer;" and an average advance of 4½ feet per shift is obtained.

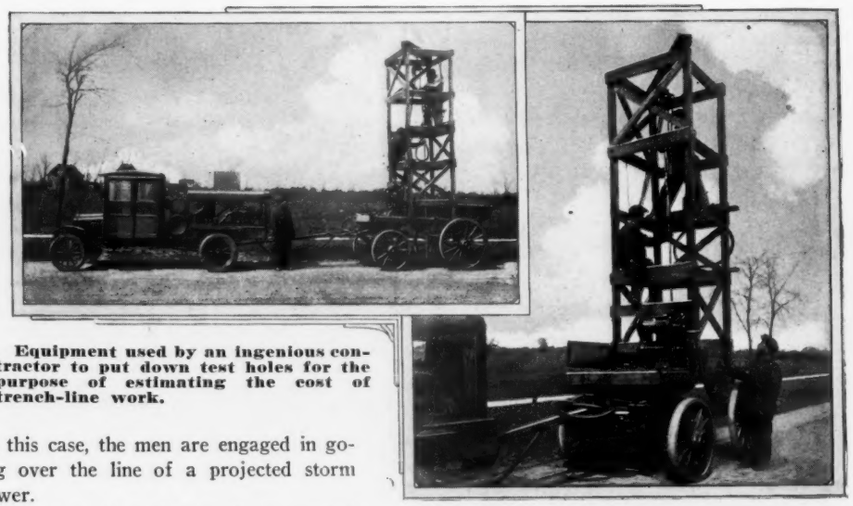
Nearly every line of industry has its quota of what economists term "marginal producers" who are able to work at a profit only during periods of great business activity when prices are at the highest level. Any machine or process that reduces operating costs tends to help the marginal producer to enter the ranks of permanent enterprises. In many mining districts there are properties that were abandoned as soon as the cost of fuel rose to a point which prevented profitable working. Similarly, there are other isolated gold and silver projects awaiting development that can be opened up and maintained only by the aid of a power plant that is moderate in first cost and economical to run. In view of all these facts, isn't it reasonable to assume that the portable, gasoline-driven compressor of today will make it possible to operate many small but promising properties that otherwise would have to remain idle?

For the benefit of those who are not familiar with portables suitable for work of this class it may be said that they are complete, self-contained power plants. Each consists of a single-stage, duplex, vertical compressor, driven by a 4-cylinder, 4-cycle, heavy-duty, tractor-type gasoline engine, and of a receiver, fuel tanks, sectionalized radiator, and controlling devices, all mounted on a heavy steel frame. The sheet-steel canopy and the removable side doors provided are generally sufficient to protect the machine from the elements or from tampering.

To suit varying needs, different types of mountings are available, such, for example, as steel wheels, wooden artillery wheels with rubber tires, flanged wheels for railway tracks, highway trailers, or skids. The smallest units can also be mounted on motor trucks, if desired. All the machines can be readily dismantled if necessary in order to meet unusual conditions of transportation. For instance, with the type of seaplanes now in service in Canada, it would be quite feasible to carry either a 1- or a 2-drill machine by air. The former could be knocked down and taken in one load while the latter would require two or more trips.

MOUNTED PAVING BREAKER DRIVES TEST HOLES

NO, the accompanying photographs do not show linemen in action, on the contrary, the towerlike structure is designed to assist in work under and not above the ground. In short, the equipment was devised by an ingenious contractor to speed up the driving of test holes preparatory to estimating the cost of digging trenches for one purpose or another.



Equipment used by an ingenious contractor to put down test holes for the purpose of estimating the cost of trench-line work.

In this case, the men are engaged in going over the line of a projected storm sewer.

By means of a paving breaker, mounted on the special trailer and drawing operating air from the portable compressor, the contractor was able to drive a 1⅛-inch rod in five minutes to a depth of ten feet first through from six to seven inches of hard macadam and then through hard clay bearing small stones. As it also took five minutes to pull out the test bar by means of a chain block, the contractor is planning to mount an air motor hoist on his trailer. This will make it possible to withdraw the rod in a few seconds.

On an earlier job the practice was to drive a 1⅛-inch bar to a depth of twelve feet, to pull the bar, and then to follow it up with another rod ⅞ inch in diameter, sending the latter down fourteen feet. This work required from seven to ten minutes, depending on the nature of the material penetrated. On another occasion, when 19-foot holes were being put down by the aid of the specially mounted paving breaker, three men did as much testing in seven hours as six men were able to do formerly in six 8-hour days. Test holes were driven every 300 feet; and from fifteen to eighteen holes were made per day. The tower is eighteen feet high and hinged midway so that it can be conveniently used for driving holes from six to eight feet deep.

GIFT OF REGIMENTAL COLORS

THE November meeting of the United Engineering Society, held in New York City, will long be remembered by those in attendance, as it marked a memorable event in the annals of the Society. At this meeting, attended by prominent engineers, army officers, and representatives of the State of New York, the colors of the Twenty-seventh Engineers, were given to the United Engineering Society.

Mr. Walter R. Ingalls, President of the Association of Twenty-seventh Engineers, acted as chairman and briefly told the story of the organization of the regiment. Another speaker was Colonel O. B. Perry, commander of the Twenty-seventh, who broadly outlined the service performed by his men overseas. In concluding his remarks, he said: "It seems proper and fitting that the colors of the regiment should be deposited with the United Engineering Society in this building, which is in itself a monument to the work of engineers."

In receiving the colors, Mr. William L. Saunders, President of the Society, fittingly said: "On behalf of the trustees of the United Engineering Society I accept the custody of these colors of the Twenty-seventh Engineers as a permanent memorial. In doing this there rise within us feelings of emotion mingled with pride and obligation. We think of this brave body of mining engineers and mine workers who, for the first time in history, organized a regiment and volunteered their services . . . to the cause of liberty and democracy. And here, for the first time, there is established in these halls a memorial in their honor and for the guidance and emulation of future generations."

Off the Beaten Track in Africa

Prospecting and Hunting in the Land of the Lords of the Forest

By OWEN LETCHER*

ONE OF the outstanding features of the Africa of the present day is the extent of the mineral development that is taking place in the hitherto untrammeled portions of that continent. Vast regions, which, so it seems, were only yesterday well-nigh unmapped, are now being scoured for mineral wealth. Under the stress of this exploratory work, the area of the real unknown and primeval Africa is contracting. The prospector and the small-mine operator are driving a spearhead of civilization into the bush and forest, into the uncharted plains and the sterile deserts. After the pioneer comes the financier, the company promoter, the transport rider, and all the heterogeneous elements which make up a mining community. Later will come the railroad, the big plant, and the town; and in this manner Africa's jealously guarded secrets are being wrung from her in a large portion of the heart of the continent.

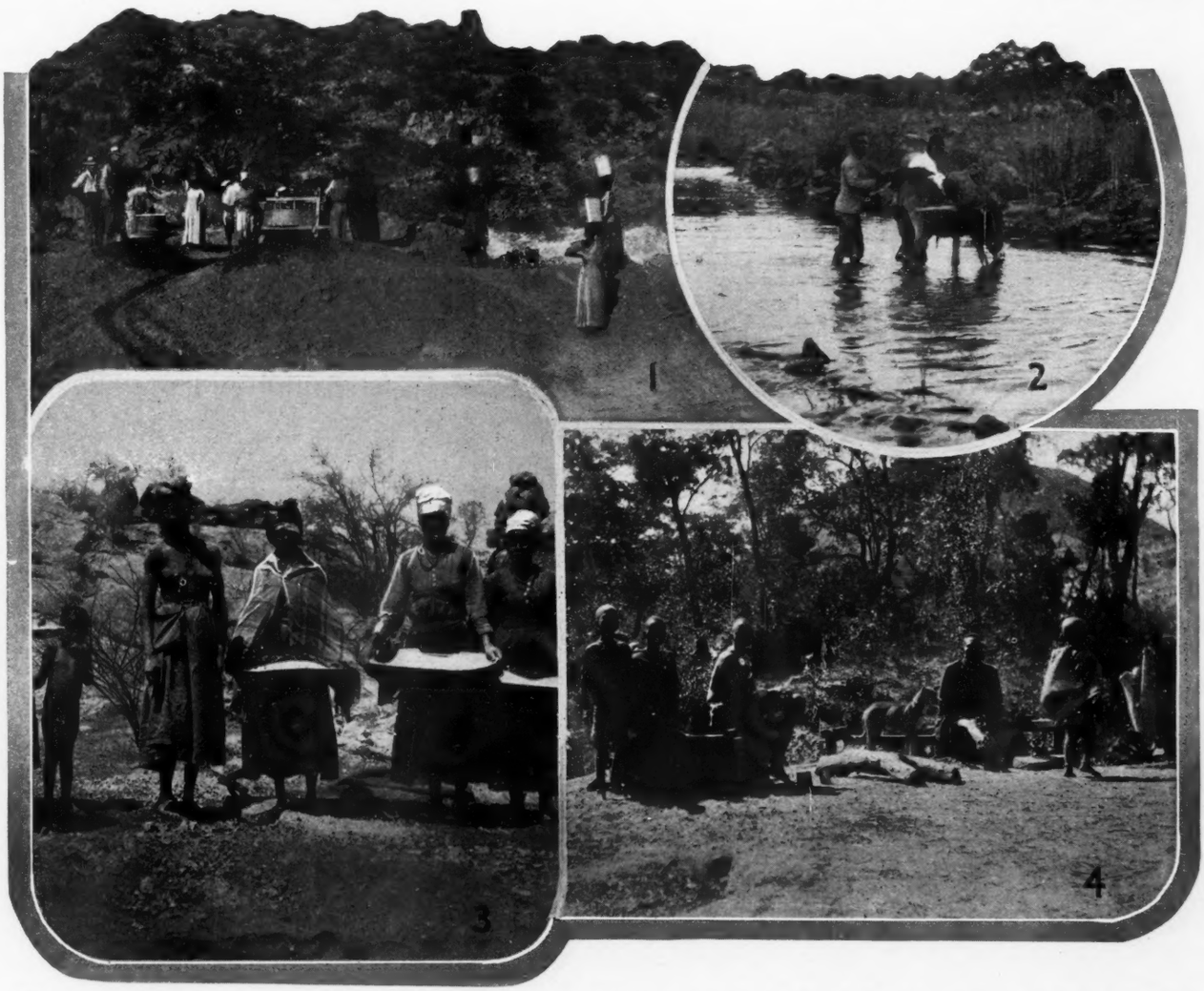


Fig. 1—Tin-mining prospect in the Southwest African Protectorate. A small compressed air plant is about to be installed at this venture. Fig. 2—How the prospector carries his impedimenta around in Mashonaland. Fig. 3—Bergdamara women winnowing cassiterite. This is the crudest form of concentration in the world. Fig. 4—Native family group in Southern Rhodesia.

It is, of course, all part and parcel of the great game of advancement, of industrializing the modern world. The white man's requirements must be gratified, and no tract of territory will be allowed for long to retain a status of consecration to Nature if it be found to contain metals or minerals of which the busy, striving world stands in need. Large sections of Africa, which hitherto have not had their primitive serenity challenged, are at last bowing to the inexorable fate. However readily we may recognize that the demands of the twentieth century necessitate this development, it is indisputable that this relentless progress cannot fail to occasion a severe heartache in many men who love Nature for Nature's sake, who have heard and answered the call of the wilds, and who have experienced the mystic spell of the unknown.

Mineral exploitation means the thinning out of game and the establishment of the mine and the railroad. It means the transformation of the bush-robed *kopjes,* where the leopards lurk, into power plants, dwelling houses, offices, and railroad stations. One who has tramped this country before it began to attract the attention of the stock market, and who has heard the lion's "wuff" at night where

Editor, South African Mining Journal.

shortly a stamp battery may be breaking the silences, cannot but feel a strong tinge of personal regret when he learns of his old hunting grounds being violated by wealth seekers.

Prospecting and hunting go hand in hand in Africa; and the photographs accompanying this article serve to illustrate the kind of life a mining engineer may enjoy if he be fond of adventure and keenly interested in all the fascinating problems of the wondrous *fauna* and *flora* to be found there. The pictures also show a small tin-mining plant in operation in a remote corner of that continent; and, perhaps, it might be worthwhile first of all to allude to the conditions under which the prospect is being worked.

Some of the photographs were taken in the Southwest African Protectorate which, prior to the great war, belonged to the German Empire. It is for the most part a dry and arid country; and the tin-mine operators had well-nigh insuperable difficulties to contend with in the development of the enterprise, which is an immense undertaking with vast potentialities. Lack of transportation and water proved the biggest handicaps. Omaruru, 50 miles distant, is the nearest point on the railway. A narrow-gage line runs through this little town on its way to the Otavi copper mines; but the actual distance to the tin mine does not convey the slightest impression of the difficulties which have to be overcome in making the journey. As a matter of fact, there is no road at all, merely a track across rough and rocky ground and through thick and burning sands of dried-up river beds. For a considerable time the absence of water close to the property was a great deterrent to progress, but recently a fairly plentiful supply has been encountered in a shaft. Encouraged by this, as well as by the maintenance of good values, the company has decided to expedite development by means of a small air compressor plant.

The method of ore treatment hitherto in vogue at this mine probably constitutes the crudest form of concentration adopted anywhere in the world. The ore is hand broken; and the native Bergdamara or Klip-kaffir women then sift the heavy cassiterite particles from the gangue by winnowing. They employ large spoon-shaped wooden pans or dishes and, after imparting a dexterous shake to the *batcas*, secure a crude but nevertheless fairly satisfactory classification by letting the broken ore fall through the air so that the light and worthless particles are carried further afield than the heavy stanniferous concentrates. Despite these primitive practices, which are in the main the consequence of a scarcity of water and the remoteness from any industrial center, the tin output of this area is increasing. There are numerous small properties working and producing tin in this part of Damaraland, and the gross output of these last year had a value of approximately $200,000. Encouraged by the recent substantial advance in the price of tin, operators are increasing their activities; and with any material improvement in the situation, both as regards water and freight, Damaraland should become a contributor of considerable importance to the world's production of this metal.

This section of Africa is barren and inhospitable, and more than one man has got lost there and died of thirst. Yet it has its fascinations. Nowhere else in the world have I viewed such gorgeous sunsets; any artist who painted such a complex of splendor as is to be seen at any dusk from the hills of Damaraland would be accused, at least, of extravagance. But the colors—the blazing crimsons, the somber purples, and the more delicate blues and yellows—light the sky in glory every evening. Even the grim and gaunt old mountains and the arid plains grow on one after a time; and the supreme silence and vastness of it all sear into one's soul. Often, when I have stood amazed at all the stress, bustle, noise, and seeming confusion of immense cities like New York and London, I have felt homesick for those far-away plains of Damaraland where the jemsbok, springbok, and other antelopes wander and draw food and water from the desert and where lions and leopards still roam in fairly large numbers.

Luangwa valley is the world's finest hunting ground and totally different from the country just described. Some of the accompanying photographs illustrate scenes in Northern Rhodesia and Nyasaland, which, not long ago, were collectively termed British Central Africa. One portion of this territory, Northeastern Rhodesia, contains what is probably the finest and least trammeled big-game hunting ground to be found anywhere on earth at the present time. It is not as well known as Kenya Colony or British East Africa, both of which have of recent years become the fashionable mecca of so many American and European *shottists*. It is much less accessible and less healthful than the East African plains. There is not a single inch of railroad in Northeastern Rhodesia; and travel there as fast as you may from any point on the African seaboard you cannot avoid rough journeying for a week or two before you even come within sight of the good hunting grounds. Tropical fevers are rife, and in some areas there is considerable risk of contracting that fell African malady of sleeping sickness. But if you are prepared to put up with these discomforts and to take a chance as regards health you will find in the Valley of the Luangwa—one of the chief tributaries of the Zambesi—an unadorned and savage Africa, the home of great beasts and strange people, Africa sometimes forbidding and almost terrifying and yet very wonderful in all her Pleistocene splendor.

Big-game hunting in this sportsman's eldorado is a comparatively cheap pastime. Native porters are to be obtained for a few shillings a month, in fact, in some parts of the Luangwa they will carry loads weighing from 50 to 60 pounds for scores of miles for a yard or two of *limbo*—a cheap low-grade fabric, or for the surplus meat which the hunter bags. Good gun bearers, trackers, cooks, and personal servants demand a little more. For a pound sterling a month plus a reasonable present at the end of the shooting trip I have had a Yao hunter boy who would spoor or track a small antelope over hard rocks and who would stand by you in the tightest corners without turning a hair. For £25 you obtain a license which permits you to shoot four elephants and every other kind of big game excepting giraffes, which are well protected; and, with any reasonable luck, the sportsman should easily clear all his expenses with the proceeds obtained from the sale of ivory.

There are great numbers of elephants in Northeastern Rhodesia, and among them plenty of big tuskers. But it is exceedingly hard work hunting them. You may have to travel and sleep on the spoor for three days and nights or even more if you are on the tracks of a monster and wary old bull, for elephants travel great distances. If you are keeping close on jumbo's heels you may have to desist from firing at any other kind of game throughout the chase, inasmuch as an elephant once alarmed will very quickly put a score or more of miles between himself and his pursuers. And when at last you do come up with the great beast, although you may be tired and worn and perhaps have a slight fever to disconcert you, your aim must be steady and your nerves calm. It is no good "browning" aimlessly into a herd of elephants either from the point of view of not infringing the game regulations, which are pretty rigorous, or from that of your own personal safety.

It is generally about midday, when the great pachyderms are seeking shelter from the merciless heat of the overhead sun, that you come up with them. They will probably be clumped together in the thickest jungle, and your principal difficulty will be to make out the forms of these lords of the forest and to satisfy yourself that the biggest tusks belong to the particular animal at whose brain or heart the sight of your rifle is directed. Elephants are exceedingly shortsighted creatures; and on account of the nature of the country in which they generally are to be found—in Central Africa—you will no doubt have to take your shot at close range, probably at not more than 40 or 50 yards, perhaps less.

Should you elect to go elephant hunting, be sure to remember that even though they have poor vision their senses of smell and of hearing are extraordinarily acute. Therefore, "wind" has to be carefully studied. Your hunter boys will attend to this for you; and the operation must be carried out in absolute silence. I can assure you that if you happen to step on a dry twig as you are approaching the herd it will sound to your keyed-up nerves like the blast from a 15-inch gun! For all these reasons it will be obvious why the reconnaissance of the enemy should be most cautiously executed before opening fire. And beware of the elephant slightly detached from the main group, one maybe lying out on a flank and not always discernible. As like as not it will be a light-ivoried old cow with a calf; and, although it is stupid to attempt to lay down any hard and fast rules as to what line of action wild animals will adopt under certain conditions, it is not improbable that the old lady will charge at the sound of the rifle.

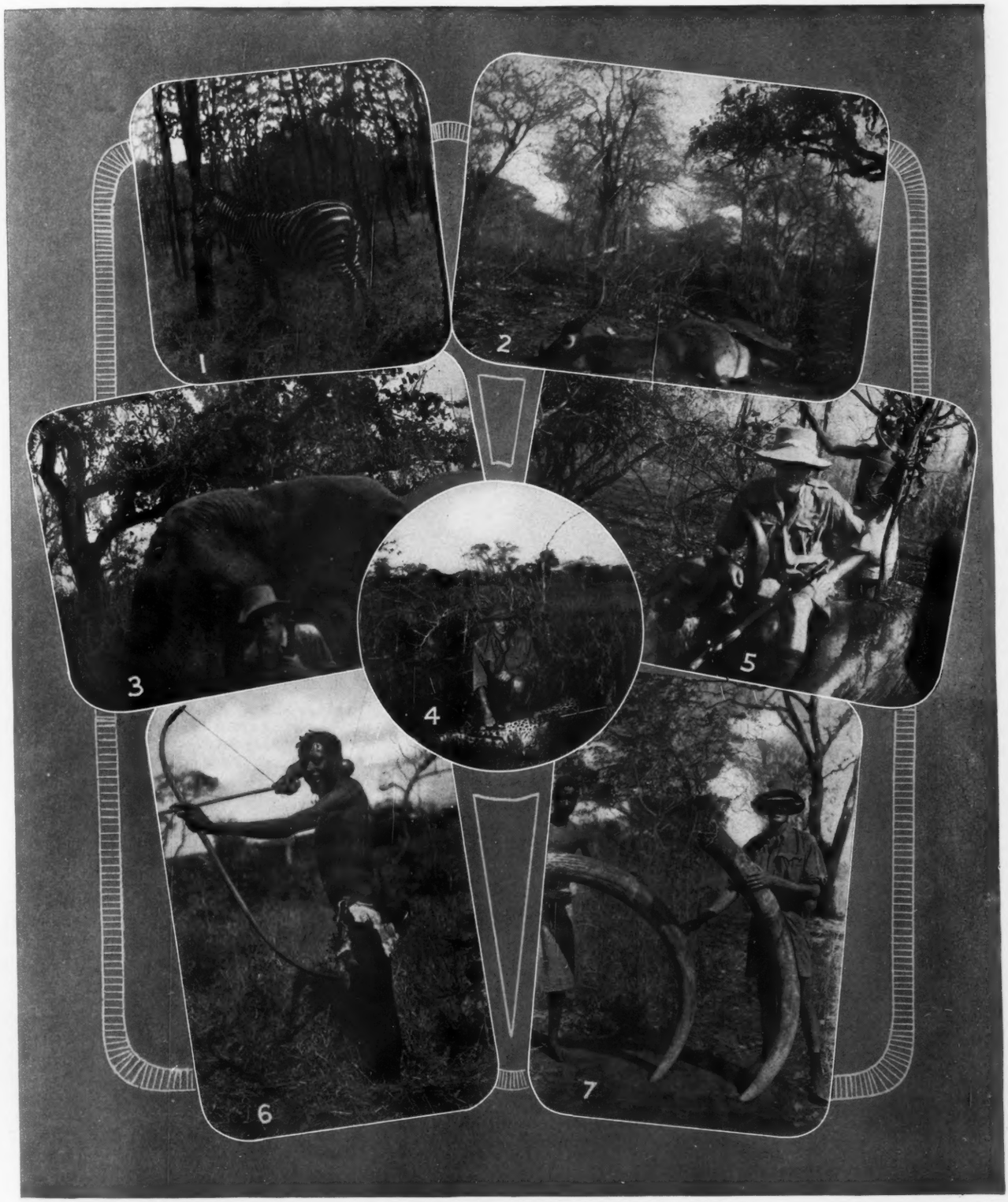


Fig. 1—Zebra in British Central Africa—his native habitat.
Fig. 2—Pookoo antelope shot on the banks of the Luangwa River.
Fig. 3—A license fee of 25 pounds sterling permits a hunter to shoot four elephants, besides other big game.
Fig. 4—Africa is the huntsman's paradise. A cheetah bagged in Northwestern Rhodesia.
Fig. 5—Monster buffalo brought down in Central Africa. A wounded buffalo is probably the most dangerous of all beasts.
Fig. 6—A native archer of Portuguese Zambesia.
Fig. 7—Fine pair of elephant tusks weighing 144 pounds.

Left—Native village in Nyasaland. Right—Study in arid Damaraland: a water hole in the desert.

It is a fascinating country this Valley of the Luangwa, where the night breezes come sobbing down through the kygelia trees and the air is full of mysterious whisperings. Here you will learn from the natives of an immense amphibian, which they call the chimpakwe; and you may hear of the place where the elephants die which, according to the Wawemba and Wawisa tribes is the common mausoleum of these great animals.

How much is truth and how much is fabulous fiction in these and similar tales told in this far-away valley of the interior of the Dark Continent? Who knows? Scientists and savants may ridicule them; but zoölogists scoffed at the reported existence of the okapi until Sir Harry Johnston brought a whole skin of this curious quadruped to Europe from the Eastern Congo forests. There are, at any rate, a few white men—professional hunters, traders, and "men who used to be white"—who have lived almost as natives in this territory for 30 years and who believe that these are not fairy tales. I will not say that I am convinced of the existence of the chimpakwe, or that I am satisfied that there is a spot in Africa to which all elephants migrate when they feel the pangs of death upon them. But I do protest this, that a fairly lengthy residence in Africa has made me believe that the truth of the old adage, "Always something new from Africa," will be exemplified for many years to come and that amongst the untutored natives and the wild beasts of the interior there are more things than Horatio ever dreamed of in his philosophy.

In one or two isolated corners of British Central Africa prospectors are busy, and encouraging mineral indications have been noted. It may be that in the course of time there will be considerable industrial development in the territory of which I have written; but the greater part of Northeastern Rhodesia with its Valley of the Luangwa is likely to remain a virtual *terra incognito* for many decades, as Nature has here reared up her great buttresses to keep this playground of the wilder animals and beasts inviolate. It may be that years hence the advance guard of civilization will penetrate into this Valhalla of barbarism: perhaps in the interests of what we call civilization it is necessary that this should come to pass. But, I must confess, that I should hate to hear a stamp battery beating out its tap tap tap-tappity tap where a hippopotamus lullaby has soothed me to sleep and where the satisfied roar of a lion, after he has killed and fed in the dark hour which precedes the dawn, has been my reveille.

Group of Klip kaffirs and their hut in Southwest African Protectorate.

TIDAL POWER PROJECT IN CANADA

PROGRESS is being made in the survey of the water-power possibilities at Lubec Narrows, in the Bay of Fundy, where a group of observers is engaged in calculating the action and the rise and fall of the tides. It is understood that the plants contemplated include the erection of a dam at Lubec, another between Deer and Campobello Islands, a third between Eastport, Me., and Deer Island, and a fourth across Letite Passage.

It is estimated that sufficient power can be generated at the Lubec Narrows to turn the wheels of every factory in the New England States. If carried to conclusion, the project will be a larger engineering undertaking than the construction of the Panama Canal, and will call for massive concrete tidal dams costing millions of dollars.

SAND BLAST IMPROVES WORK IN REPAIR SHOP

IN the shops of the Kansas City Railway a sand blast is in continuous service and proves useful and time saving in overhauling and repairing cars. Some of its services are spoken of appreciatively in the *Electric Railway Journal.*

Men will do better work on parts if the latter are first cleaned when taken off the cars. Therefore, in addition to cleaning the sides of the cars, the sand blast is employed to clean truck frames, parts of door and step mechanisms, dash plates, and miscellaneous parts. This makes them easier to handle, and considerably improves the character of the repair work. By sand blasting the surfaces of new castings, defects, cracks, and blowholes are disclosed which might otherwise be undiscovered. In this way no time is wasted on worthless material.

A paving program for Tokyo, laid out by the local Bureaus on Reconstruction and Road Construction, involves surfacing the equivalent of 211 acres of streets before the end of 1927.

Constructing The World's Longest And Largest Welded Gas Main

What is Being Done in the South to Draw Natural Gas from Wells in Louisiana and to Deliver It at a Point of Consumption in Texas

By ROBERT G. SKERRETT

NATURAL gas is a boon to those sections of the country where its daily use for domestic and for industrial purposes has become firmly established. It is a boon because it furnishes heat and motive energy without recourse to the burning of coal with its incidentally troublesome and somewhat expensive problem of ash disposal. Indeed, natural gas as a fuel is generally cheaper, cleaner, and, withal, more convenient than either oil or coal for similar services. Further, it costs less and is of higher thermal value than manufactured gas.

But the supplies of natural gas are, unhappily, not inexhaustible; and year by year the distributors of this fuel are obliged to go farther afield to obtain sufficient quantities to meet the demands of old and of new consumers. The longest and the largest pipe line for this purpose is now under construction, and when finished it will link gas wells at Serepa, La., with Beaumont, Tex.—separated by an interval of substantially 224 miles.

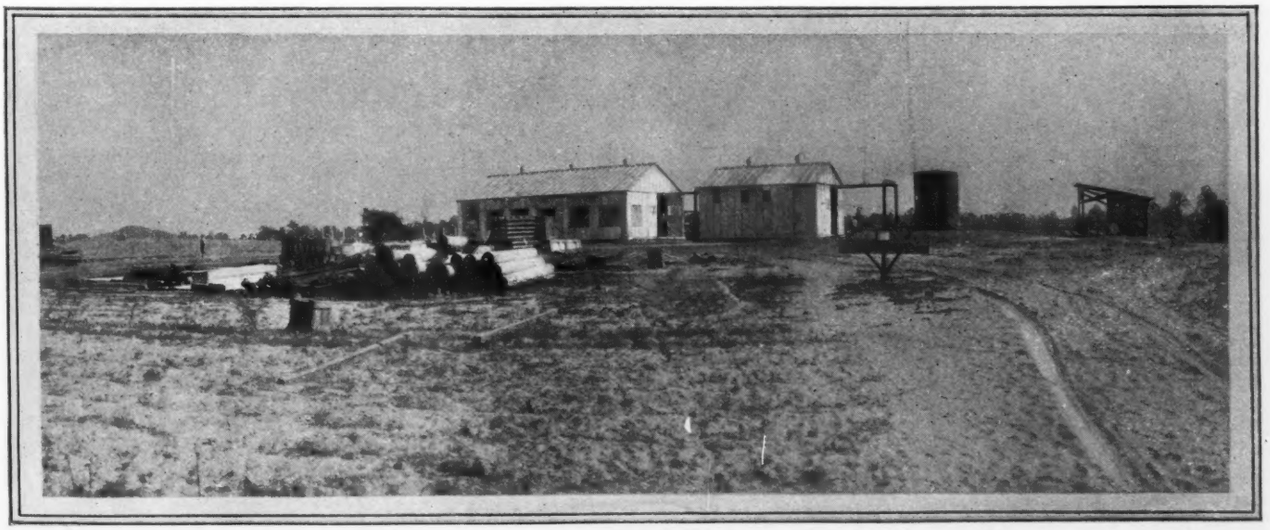
The gas, in question, is what is technically known as dry gas. That is, it comes from the bowels of the earth without bearing with it any appreciable percentage of suspended gasoline which might be profitably extracted from it by any of the existing commercial processes. In brief, the gas is of a character that renders it immediately fit for home or industrial uses. To the layman, the transportation of this gas might seem a rather simple engineering task, but as a matter of fact its successful distribution bristles with difficulties; and everyone of these received very careful consideration before the final plans for the line and its associate equipment were decided upon.

TRANSPORTATION, to the majority of us, means the carriage of more or less heavy matter for varying distances. The story we are about to tell, however, deals with the moving of enormous quantities of a nearly weightless substance 200 miles and more in order that this raw commodity — drawn from the depths of the earth—may be delivered to a sizeable city where it will best serve man's immediate purposes.

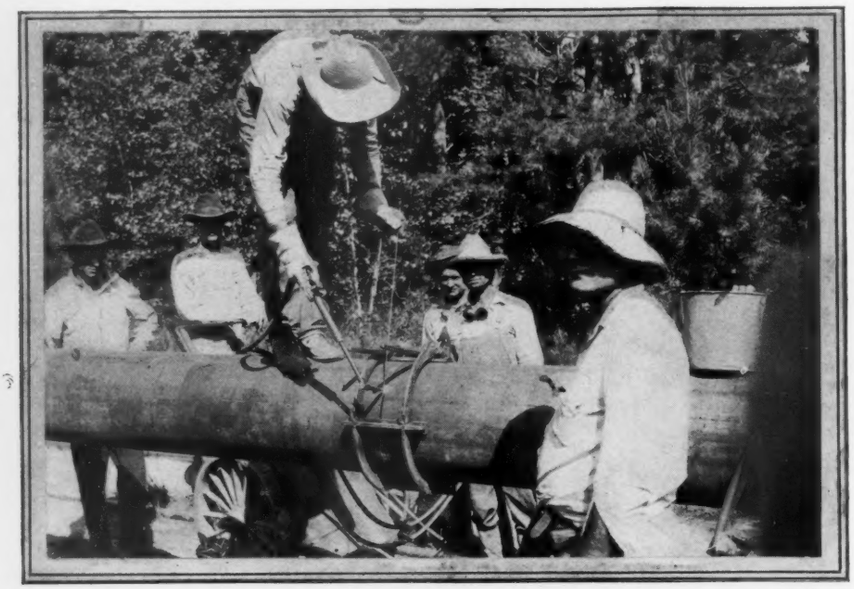
In brief, we are going to describe the construction of an exceptionally interesting main through which natural gas will be distributed from a source in Louisiana to a point of consumption in the State of Texas. In carrying out this work—which is still underway—compressed air is performing a number of useful and essential services.

Most of us never think of it, but changes of weather are very largely induced by the differing densities—reflected by variations in barometric pressure—of neighboring or remote areas of the atmosphere we breathe. Conversely, the temperature at any point will either increase or decrease the density of the air and cause it to occupy a larger or a smaller unit of space. In much the same fashion, the quantity of natural gas which can be forced at a predetermined cost through a main will be controlled by the temperature as well as the pressure of the gaseous medium. Furthermore, where this gas is to be transported long distances it is essential that the temperature be held as nearly constant as possible; and where changes do take place in this respect it is necessary that the size of the conduit shall be varied so that the altered volume of the gas may have a channel through which it can flow without any pronounced drop in its velocity. There is a velocity of maximum efficiency at which gas at a given initial pressure and temperature can be blown through a long main with the least expenditure of power on the part of the propelling machinery. So much for some of the fundamental principles that must be taken into account in designing such a pipe line as the Magnolia Gas Company of Texas now has under construction.

The pipe line between Serepa and Beaumont consists of three interconnecting divisions with two booster stations located, respectively, at points 60 and 136 miles from Serepa. That is to say, the second of these stations builds up the reduced pressure of the arriving gas sufficiently to send it on at the prescribed velocity through the remaining 88 miles of the pipe line which terminates at Beaumont. The



One of the booster stations along the line where the gas pressure is built up by powerful compressors in order to send it on its next lap at the desired velocity.



Spot welding or "tacking" two pipe joints preparatory to making a complete weld.

first booster station has been named La Tex, while the second one is called Magasco in recognition of the Magnolia Gas Company. An accompanying diagram shows the relations of the various stations and terminal points and, incidentally, indicates the lengths of the different sized piping used to insure a uniform flow of the gas. As additional evidence of the complexity of the problem it might be mentioned that in each division of the line there are no fewer than nine different thicknesses of piping.

The building of the line was started last June, and the entire job will take fully a year's time to complete. Broadly stated, the undertaking may be divided into four phases: first, the clearing of the right of way and the digging of the trench for the main; second, the assembling of the various sections; third, the testing of each succeeding section for gas tightness; and, fourth, the laying and the burying of the finished conduit. Each section is composed of 20 units or joints which, in their turn, are of an average length of 17½ feet. Therefore, each section is substantially 350 feet long. The respective joints are of lap-welded piping, and the unit lengths are linked by oxy-acetylene welds instead of by bolting in the manner commonly employed. After a section has been put together and tested it is welded into the main line; and while the pipe is being dropped into the yawning trench it is purposely handled somewhat roughly in order to subject it to treatment which will reveal any structural weaknesses. That is to say, the welds are supposed to be fully as strong as the unit lengths, themselves.

For the sake of those that are normally interested in the bigness of things, it should be pointed out that this gas main, when ready for service, will be the longest and the largest welded line built up to date. The system of welded joints was chosen because it would produce a physically continuous conduit, throughout each division, that could not pull apart and leak by reason of expansion or contraction. The natural undulations due to following the ground contours allow for sufficient longitudinal movement—due to expansion and contraction—to minimize the development of rupturing stresses at the oxy-acetylene welds. The line, when in use, will function as a high-pressure main; and, therefore, it is very important that there shall be the least likelihood of leakage. In some gas lines the loss by leakage ranges anywhere from 10 to 30 per cent. of the volume pumped into them, and the longer the line the greater is this wastage.

Through the Serepa-Beaumont conduit there will be sent daily a volume of from 40,000,000 to 50,000,000 cubic feet of gas. Assuming a monthly consumption of 1,000 cubic feet of gas per capita, there would be sufficient gas at the lower figure to take care of the ordinary domestic needs of a city having a population of 1,200,000.

The right of way of this unusual gas line traces its course through diversified territory. That is to say, it traverses stretches of rolling country that are, for the most part, devoid of trees and entirely exposed to the hot summer sun; again, the route is through heavily timbered areas; while at other stages the main is being advanced through swamp lands, bayous, and beneath a navigable river. However, for much of the way the line is not in touch with accessible sources of water, due to a prolonged drought; and this fact bears directly upon the reason for the present article.

The common practice in testing large gas mains for tightness is to seal the two ends of a section and to subject it to hydraulic pressure. This answers satisfactorily when water is handy and the piping can be filled, emptied, and refilled easily, if necessary. Therefore, the engineers of the Magnolia Gas Company adopted this procedure while laying the first ten miles of the main. After that length of the line had been constructed the scene of operations got beyond a convenient water supply; and yet it was essential that the succeeding sections should undergo conclusive tests for gas tightness. Accordingly, the men in charge elected to substitute compressed air for water for this purpose.

As already explained, each tested section was made up of twenty joints or unit pipe lengths. These were brought in contact, end for end, and then spot welded or "tacked" while held in position by a suitable clamp, such as is shown in one of our illustrations. Next, the welding was completed circumferentially—using the oxy-acetylene torch to fuse and to deposit the binding metal. As most of our readers are undoubtedly familiar with this process we will not describe it here.

Despite the care exercised by an expert welder, still he not infrequently fails to deposit enough metal to make a thoroughly gas-tight union—especially when the weld is subjected

Welding in a connection close to a "bullnose." The latter is employed to seal a pipe section before testing it for tightness.

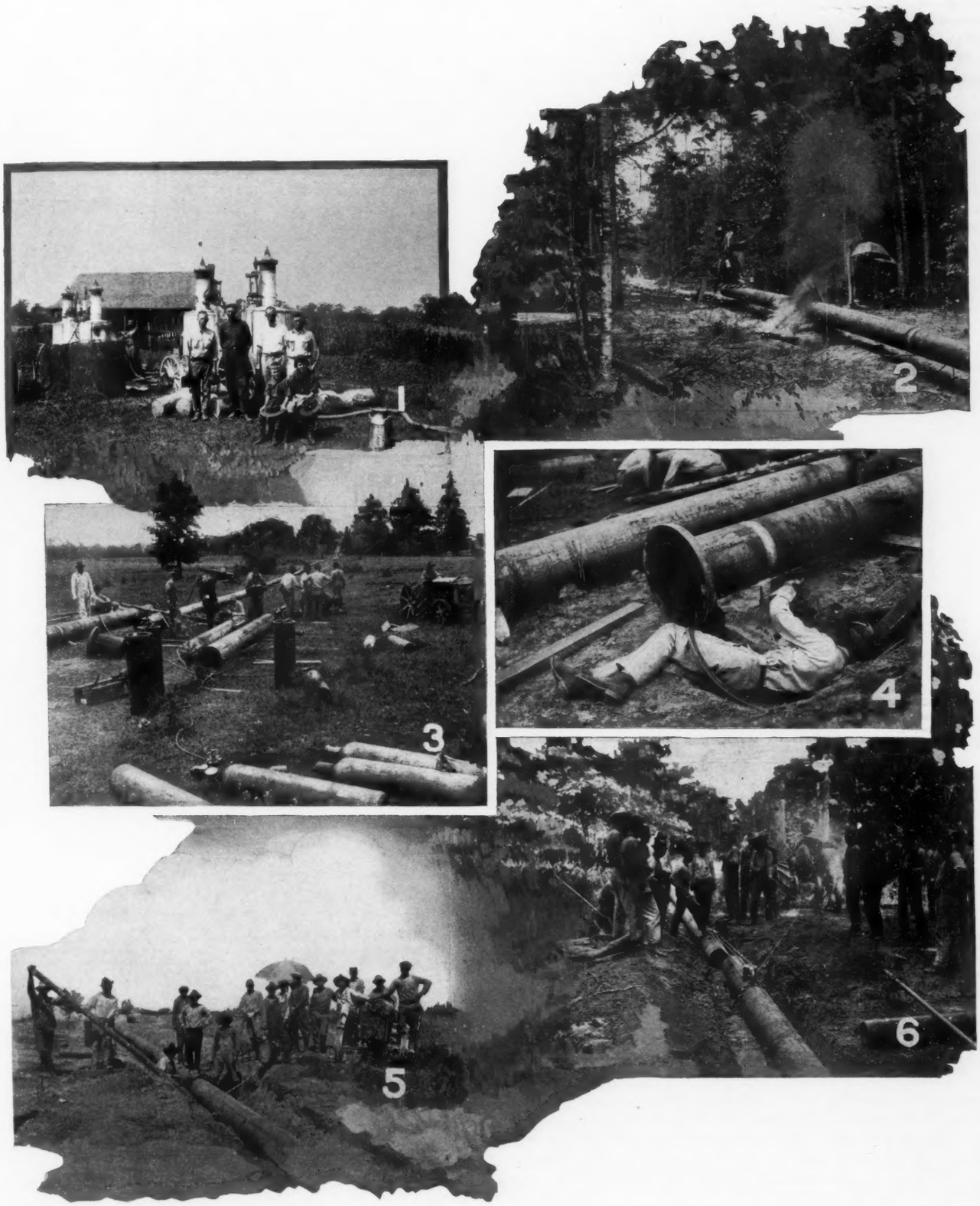


Fig. 1—A battery of portable acetylene generators which furnished some of the gas used in making oxy-acetylene welds.
Fig. 2—After assembling a number of joints the piping was bent to suit local conditions by heating it, as shown, and applying a live load at the free end.
Fig. 3—Welding 18-inch gate valves into the pipe line.
Fig. 4—Welding a flange on a length of pipe by means of the oxy-acetylene torch.
Fig. 5—Drawing two sections together to complete the welding.
Fig. 6—Showing the manner in which pipe sections were brought in contact preparatory to welding.

to a high internal or bursting pressure. It should be recognized that even an occasional pin hole might offer an avenue of escape for a considerable volume of gas if the gas were under only moderate pressure, and that the wastage would grow directly with any increment of pressure. This explains why the engineers of the Magnolia Gas Company tested the line, as long as water was available, at a maximum pressure of 516 pounds. This was really not much higher than the pressure to which the gas will be raised at the Serepa pumping station and at the two intermediate booster stations.

Escaping water gives visible evidence of the point or points of leakage, and, therefore, something had to be done to make compressed air visible when using it in place of water for testing purposes. This is accomplished by coating each joint to be tested with a film of soapy water. Any escaping air immediately blows an aggregation of bubbles, and these give unmistakable evidence of the slightest imperfection in the welding. The same procedure is followed with the longitudinal lap weld in each unit of piping. For the first test the air pressure is raised to only 25 pounds, and all leaks so revealed are marked for attention and repair. With this done, the pressure is quickly released and the work of plugging the pin holes can be taken in hand without delay.

When the welders have sealed these defects, the section is again tested—the pressure then being raised to 75 pounds and the line thoroughly inspected to see that the work has been done properly and that no additional leaks have developed. If any leaks are shown to exist these are taken care of and are stopped before the section undergoes its final pneumatic test at a pressure of 130 pounds. Incidentally, it should be mentioned that a record is kept of every welder and of the character of the work done by him, and if his performance falls below an acceptable standard he is discharged, forthwith. In the whole conduit there will be no fewer than 66,666 main-line welds, exclusive of drip and valve welds, and this fact should make it plain just how necessary it is that every weld should be perfect.

Lacking water for testing purposes, the reader will naturally wonder how it was possible to furnish compressed air to take its place—especially when the scene of operations was shifted continually and was generally beyond the reach of any community boasting a stationary compressor plant. The needful air has been provided by a group of four portable compressors. These, as the designation makes clear, are moved along so as to furnish all the air necessary whenever and wherever required. The compressors are of Ingersoll-Rand make and of the well-known Type Twenty model. Two of the machines are of the 9x8-inch size which is capable of providing 210 cubic feet of free air per minute.

It should be self-evident that these compressors have greatly simplified the problem of properly and effectually testing the numerous welded joints. When water was used for testing, the piping had to be completely drained and all moisture got rid of before resuming welding, and much time was lost in refilling the section in order to retest it. The release of the testing air pressure can be accomplished in far less time; and the employment of compressed air does not introduce any troublesome moisture. Furthermore, the upbuilding of the air pressure lends itself to much nicer control; and compressed air under some conditions, because of the greater penetrative powers of the gaseous medium, will reveal weaknesses which water at the same pressure might not disclose. But the compressors have been effective agencies in speeding up operations in another and even more unexpected direction.

One of the most unique uses of compressed air in connection with the planting of portions of the main developed where some of the 18-inch sections were placed in the beds of bayous and in water from 28 to 30 feet deep. The piping was lowered into its intended resting place by means of 2,000-pound river clamps, gripping the conduit at every joint. Preparatory to lowering the piping into position it was necessary to trench the water-bed and to make the clay sides and bottoms of the excavations conform to the already bent main so that it would be suitably supported. More than once several days were lost in fruitless efforts to do

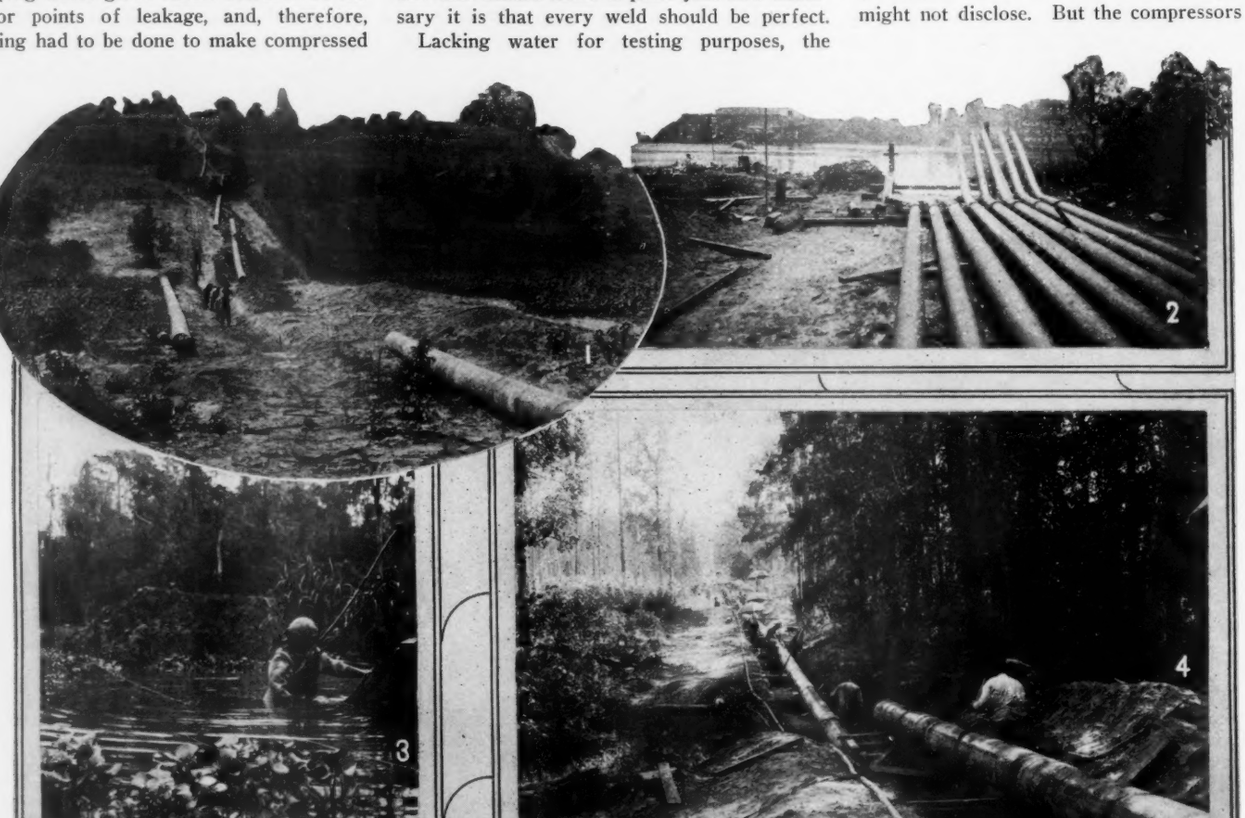
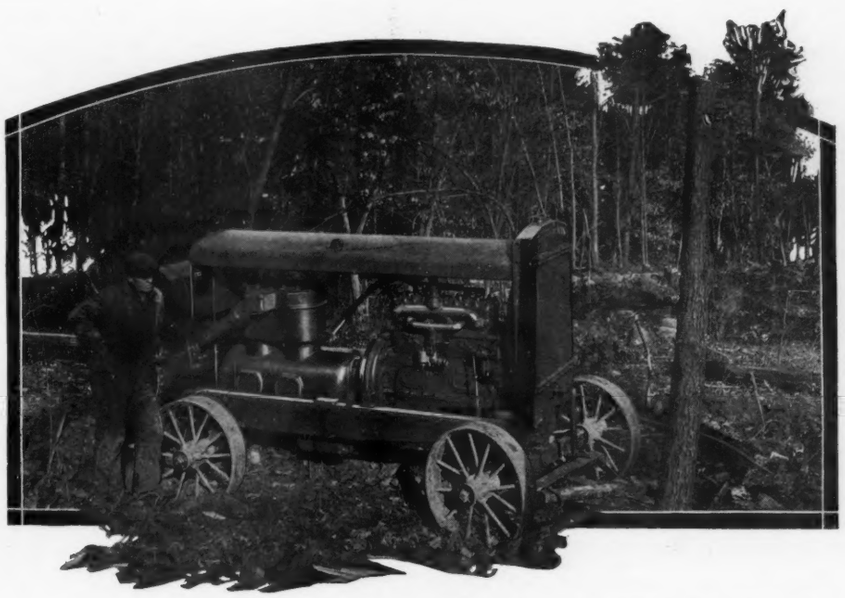


Fig. 1—A comparatively easy stretch of country for the right of way of the main line. Fig. 2—Some parts of the assembled main ready to be laid in the river trench. Fig. 3—Divers, equipped with air-driven clay diggers, cut away roots and dug trenches under water for the piping. Fig. 4—The main line preparatory to joining two sections. The sun was so hot that the welders had to be shielded from its scorching rays by umbrellas.

this trenching, and on occasions it was necessary to pull the bent sections out of the water two or three times when ordinary spades were used by divers to do the subaqueous digging. The trouble was the divers could not get a firm footing so as to be able to exert sufficient force to penetrate the heavy clay or to sever the obstructing roots of trees.

The situation had become acute when it was suggested to the engineers that the work might be done speedily and effectually if the divers were equipped with Ingersoll-Rand air-driven clay diggers. Accordingly, pneumatic spades were purchased, and the results were astonishingly successful. Where the work had been interrupted for days the task was accomplished by these clay diggers in less than two hours—the air-driven tools cutting through the clay and severing tree roots "as if the spades were slicing ice cream," as one of the officials has expressed it. The clay diggers performed perfectly at varying depths of water while being operated at their designed air pressure. Where the main rests on the bed of the Neches River it lies in a trench cut below a channel for shipping, 50 feet deep; and this work gave the pneumatic spades their supreme test. Their performance was admirable and satisfactory in every particular.



Portable compressors of this type furnished the air for testing the main and for driving the pneumatic clay diggers used to dig trenches under water.

As will be seen by reference to the accompanying diagram, the main is made up of piping ranging from 14 to 18 inches in diameter—the smallest piping receiving the gas at its maximum pressure where it starts on its journey at Serepa and where it is relayed from the booster stations at La Tex and Magasco. The 18-inch piping, on the other hand, conveys the gas throughout the last part of each lap of the 224-mile travel. The reason for this is that as the pressure drops the gas expands and needs a larger channel through which to move at a given velocity. At each booster station there will be installed a battery of compressors requiring 5,000-H. P. to drive them, and these machines will send the gas into the line at a pressure of 500 pounds to the square inch. We are not in a position to tell what this transportation system will cost when finished, but the outlay will run into a number of millions of dollars. The undertaking is a splendid example of public-service enterprise, and the Magnolia Gas Company has ample reason for pride in what it is doing for the ultimate benefit of the citizenry of Beaumont.

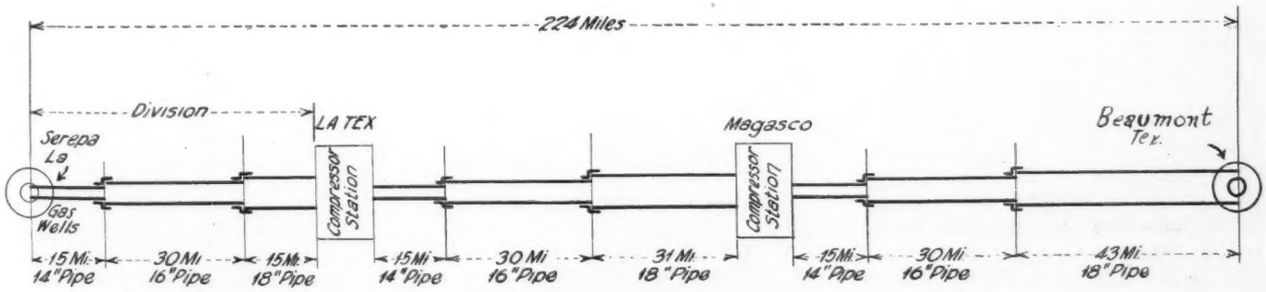
According to the *Japan Advertiser*, a system of subways 50 miles long is to be constructed under Tokyo. Fine place to be caught in during an earthquake. It is estimated that the total cost of the scheme will reach $100,000,000.

During 1923, Canada produced more than 14,500,000,000 cubic feet of natural gas. Ontario is the principal source, with nearly 8,000,000,000 cubic feet to its credit last year, although its output is said to be declining. In Alberta, on the other hand, which provided about 6,000,000,000 cubic feet in 1923, the supply is said to be on the increase. In this connection it is interesting to note that the Canadian Department of Mines is reported to be investigating the possibility of recovering helium, particularly from the natural gas found in Alberta.

INJECTING CEMENT TO STOP LEAKS IN ROCK WORK

A TASK often perplexing to the engineer is the stopping of leaks in a dam, either in the dam itself or where it contacts with the solid rock. During the past few years a method has been devised by a Swedish concern by means of which cement is injected, under high pressure, into drill holes, thus completely filling the contiguous crevices. It is said that valuable results have been secured thereby.

The cement is injected into the drill hole by a special apparatus capable of producing a pressure up to 2,100 pounds per square inch. However, in most cases not more than one-quarter of this is required. The gigantic dam of the second largest power station in Europe, at Kraftwerk Waggital, in Switzerland, is being tightened by this process. More than 4,000 yards of drilling are required for this work. Fissures encountered in native rock in tunneling have been treated successfully in the same manner.



General scheme of the gas main, pumping stations, and associate details.

Air Hoists Help In Roadbuilding

Bear Mountain-Hudson River Bridge With Its Imposing Highways Completed

By VERNON H. VANDIVER

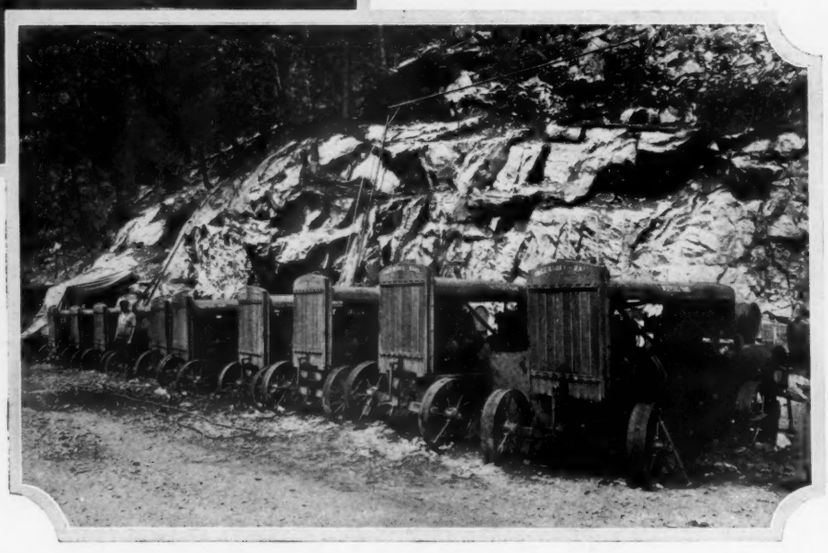
NEXT MONTH, after the Bear Mountain-Hudson River Bridge has been opened to traffic and the customary congratulations have been extended its builders, interest in this notable engineering achievement will doubtless subside—in characteristic American fashion—and turn to other newer undertakings of magnitude. But the bridge as well as the highway approaches, which give the automobilist a ride of unsurpassed scenic beauty, will stand for many decades as monuments to the progress of a nation and to engineering ingenuity.

Many of the difficult problems encountered on this mammoth project and the manner of their solution have been dealt with previously in these pages. So, with a brief recounting of the most interesting of these, we will pass on to our story. The acknowledged need of a bridge across the Hudson at some point within easy reach of the metropolitan district led to an exhaustive examination of all promising bridge sites lying between New York City and Poughkeepsie. As a result, it was decided to place a vehicular suspension bridge a few miles north of Peekskill, where the river flows between Bear Mountain on the west and Anthony's Nose on the east. The structural steelwork of this bridge was finished on October 10, at which time, with ceremonies commensurate with the occasion, the last section of the 1,632-foot center span was swung into place. To be sanctioned by the War Department, the deck of the bridge had to be high enough above the surface of the water to allow ships with towering masts to pass under it. The structure was, therefore, designed with a clearance of 153 feet above the river at mean high water.

The bridge, which cost in the neighborhood of $4,000,000, consists of six sections, as follows: the main span, 1,632 feet between the centers of the towers and containing 4,000 tons of structural steel, and the two approach spans made up of five sections—one section on the east shore, 210 feet in length, and four sections on the west shore having a total length of 410 feet. These latter spans are composed of 1,000 tons of steel. About 4,100 tons of plates and angles are worked into the towers, which are 355 feet high measured from the tops of the piers.

The main cables contain 7,500 miles of 3/16-inch, high-carbon steel wire—nearly as long as the earth's axis—weighing about 2,000 tons. These cables are 18¼ inches in diameter and have a parobolic length of 2,727 feet. Pendant from the cables are numerous 2¼-inch suspenders, for which an additional 50 tons of wire was utilized. These suspenders support the main span. The cables are anchored in four shafts which were driven downward in solid rock at an angle of 26 degrees from the horizontal. Eye-bars and special castings, weighing all told 1,000 tons, key the anchorages in place and bind the moorings to the enveloping mountain walls. Approximately 4,000 cubic yards of concrete, poured into the shafts and around the eye-bars and castings, furnish additional security for the anchorages.

To give access to the bridge it was necessary to construct 3¼ miles of roadway over very rough and precipitous country. Beginning midway between the state military camp, on the east side of the river just north of Peekskill, and Roa Hook, the way was drilled and blasted out of solid rock. At first, the road goes along the mountainside, runs back into the Valley of Brockey Falls, and then comes out on Anthony's Nose, 410 feet above



Left—One of the well-equipped blacksmith shops showing the "Leyner" sharpeners that kept the drill steels perfectly bitted and shanked. Right—The battery of 9x8-inch, Type Twenty, portable compressors that furnished the operating air for the hoists, rock drills, etc., used in building the roads leading to the bridge.

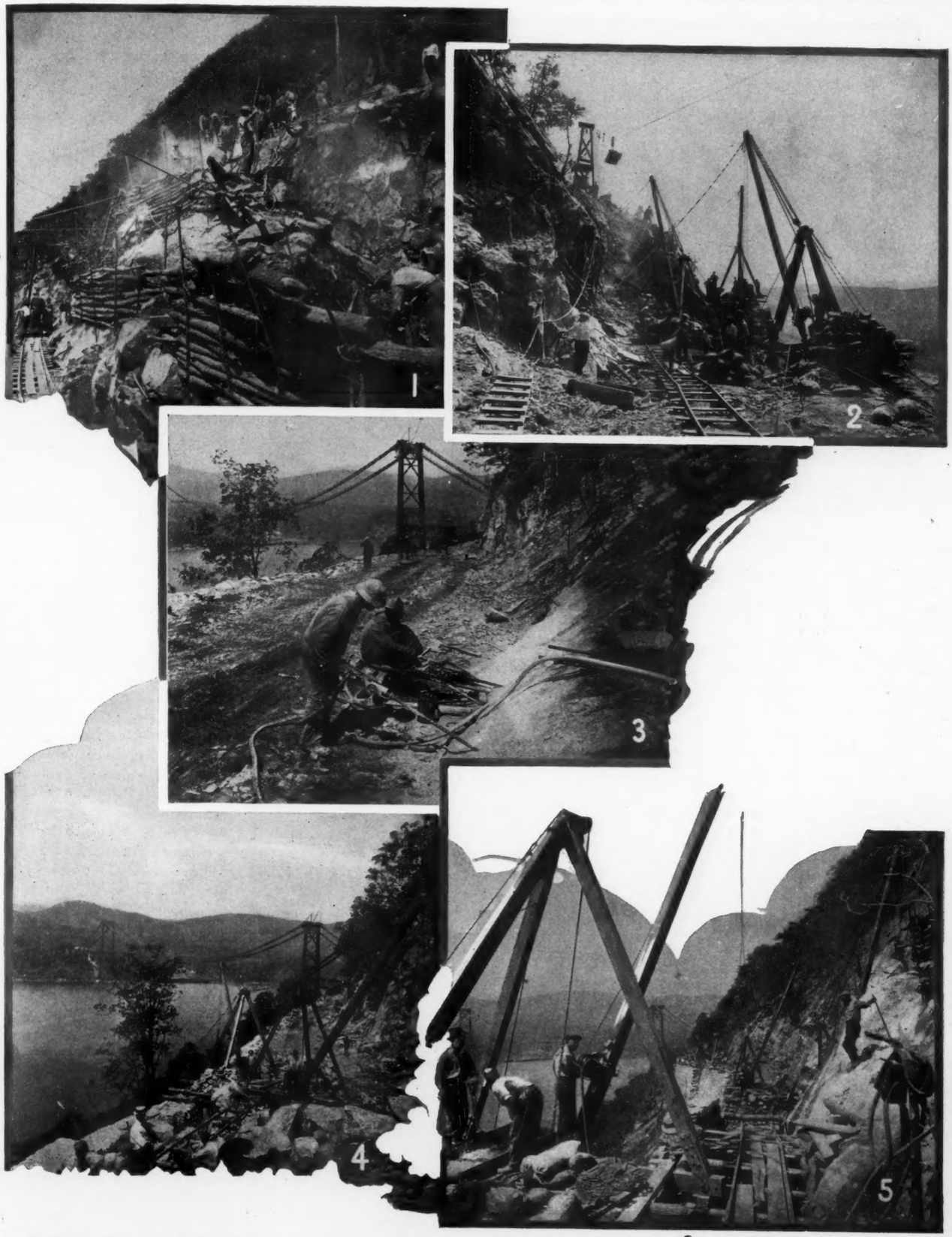


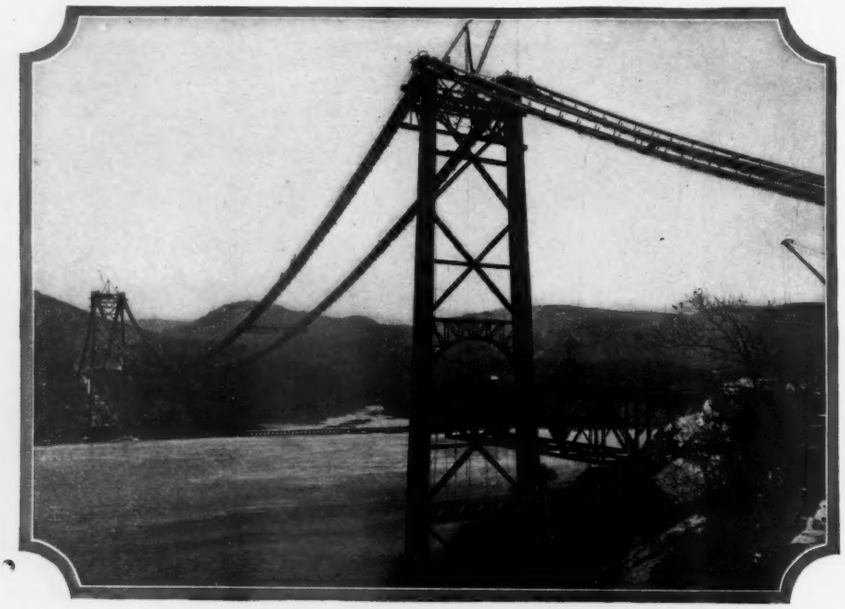
Fig. 1—In blasting out the roadway on the east shore of the river, precautions had to be taken to prevent the rock from rolling down the precipitous slopes and onto the New York Central Railroad tracks below.

Fig. 2—Placed at points of vantage, derricks equipped with "Little Tugger" hoists quickly handled the stone used in building the great retaining walls.

Fig. 3—"Jackhamers" at work widening the roadway. Where exceptionally fine views might tempt the motorist to stop, the roads have been made purposely broader.

Fig. 4—Handling rock for the construction of the retaining walls. Anyone familiar with the manually operated derrick commonly employed for work of this sort can appreciate the time and the labor that was saved here by substituting air hoists for winches.

Fig. 5—Close-up of a derrick showing the manner of mounting one of the air-driven hoists.



Here we see the great main cables with the temporary wooden foot bridges beneath. High aloft on these flimsy platforms the workers attached the numerous suspenders supporting the bridge deck.

the river, at a point about three-quarters of a mile south of the east end of the bridge. From there on it gradually descends to the level of the bridge approach, passing above the New York Central Railroad tracks.

In building this highway it was necessary to excavate 175,000 cubic yards of material of which 90 per cent. or more was rock; to fill in 107,000 cubic yards of material; and to construct 35,000 cubic yards of retaining walls. Now let us see how the contractors, The Tench Construction Company, Inc., set about the task of building the retaining walls.

To the uninitiated, the construction of a ¾-mile section of roadway around Anthony's Nose would seem to be a job well-nigh impossible of accomplishment. Not to the contractor, however, even though that particular mountainside is so nearly vertical that it takes an exceptionally good climber to descend to the river below. Yet with a portable compressor anchored to the face of the sheer cliffs and furnishing air for operating "Jackhamers," drill runners, perched on precarious footings or suspended by ropes, drilled and blasted until they had a ledge from which further operations could be carried on more rapidly and with less discomfort.

To lessen the amount of drilling and blasting to be done it was necessary to build great retaining walls varying in height from 15 to 57 feet. The highest of these walls tapers from a width of 20 feet at the bottom to 3 feet at the crest; and they were all built of rock blasted out of the mountainside and placed by means of improvised derricks. The derricks were operated by "Little Tugger" air hoists, bolted to the booms, which replaced the back-breaking hand winches commonly employed on jobs of this kind. A number of these derricks were in steady use, and they did much towards hastening the completion of the task.

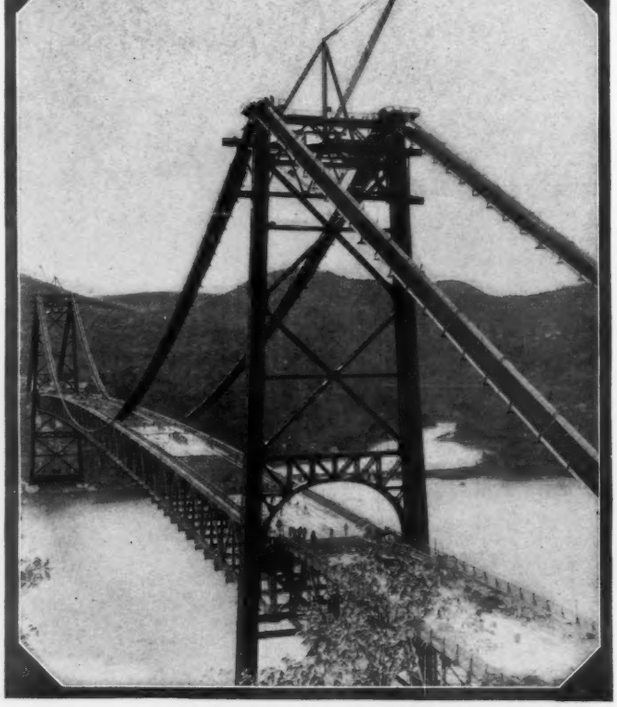
Where the higher retaining walls were located there was not always a sufficient amount of rock within reach of the derricks. In such cases, temporary tracks were laid to the nearest rock piles and dump cars utilized to convey the material. Here again a "Little Tugger" hoist was called upon to do a helpful service. In short, track mules or extra car pushers were dispensed with by bolting an air hoist alongside the track and by using its tireless energy to draw the cars.

"Little Tuggers" were also utilized to lift such materials as cement, sand, etc., from the river level to the roadway. In one locality, a cable—stretched from the lower level to a point above the scene of operations—served as a track for a trolley wheel carrying a hopper, into which the materials were loaded. The air-hoist cable was, of course, attached to the trolley; and short and easy work was made of an otherwise long and tedious job. Elsewhere, an industrial truck was used instead of the cable.

Compressed air for operating the hoists, for driving upwards of 60 "Jackhamers" and rock drills, and for actuating some 5 or 6 "Leyner" drill-steel sharpeners was furnished by a battery of 11 Ingersoll-Rand 9x8-inch, Type Twenty, portable compressors, each having a capacity of 250 cubic feet per minute.

The road has been built in accordance with the specifications of the New York State Highway Department. It is concreted, has a width of 18 feet, and has 3-foot shoulders on each side. At various places, where the views up and down the river are particularly fine, the roadway has been widened so as to allow space for parking. This foresight on the part of the engineers will, no doubt, be appreciated by the nature-loving tourist. The roadway across the bridge is 38 feet wide and is flanked on both sides by 5-foot walkways.

The entire project has been financed by private capital, operating as the Bear Mountain Hudson River Bridge Company, which looks for reimbursement to the small tolls which will be levied upon vehicles and pedestrians crossing the bridge. Payment of tolls will be discontinued after the bridge has been in service for a period of 30 years, whereupon the bridge and its highway approaches will pass free of cost to the State of New York. In this way it has been possible to finance the construction of this bridge long before public funds would have been available for the purpose. The tolls will not be ex-



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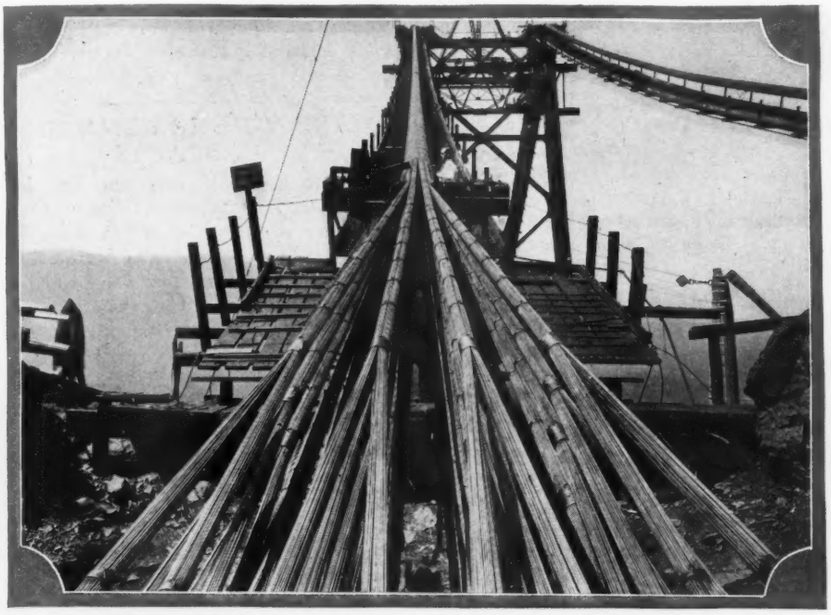
How the Bear Mountain-Hudson River Bridge looked at the end of October. Though the last section of the center span had been put in place less than a fortnight earlier, the work of concreting the roadway was in full swing.



Revealing the anatomy of one of the great supporting cables. Each of these cables is composed of 37 strands, and each strand is made up of 196 separate wires. A wonderful example of the motto, "In union there is strength."

cessive; and the bridge will at once relieve congestion on converging roads by speeding up the movement of vehicular traffic that has hitherto had to depend on ferries to cross the Hudson River.

The success of this colossal undertaking is due to Mr. Howard C. Baird, of the well-known firm of Hodge & Baird, New York City, who designed the structure; to Mr. Wilson Fitch Smith, chief engineer of the Bear Mountain Hudson River Bridge Company; to Mr. John M. Belknap, of The Tench Construction Company, resident engineer; and to The Tench Construction Company, Inc., the contractors for the entire undertaking.

MULTIPLYING MOTORSHIPS

"THE spectacular happenings of the war and the post-war periods," according to Mr. E. G. Gregg, Chief of the Transportation Division of the United States Department of Commerce, "have obscured a silent revolution in shipping which has been going on in the past fifteen but more especially in the last five years. Unseen, except by the careful observer, a force has been at work that should cause world trade to increase. This force is the motorship which, by reducing the cost of carriage, is stimulating oversea trade. In general, the motorship is today the most efficient ocean transportation unit. Although a new motorship costs approximately 25 per cent. more than a steamer of similar size it can carry goods from 10 to 30 per cent. cheaper.

"The first small seagoing motorship was constructed in 1910, and the first large one in 1912. Since that time, in spite of the fact that four war years intervened in which construction was limited largely to standard designs of steamers, motorship tonnage has increased to 1,700,000 gross tons. Of all the ships under construction in the world today more than one-third are to be equipped with Diesel engines. This large amount of motorship tonnage in commission has a distinct tendency towards keeping ocean rates down.

"The most recent development in motorship construction is in the field of the large passenger ship. Heretofore only cargo boats and small passenger-cargo ships have been equipped with Diesel engines; but in the past year, two passenger ships, averaging around 20,000 gross tons each, have been ordered and are now nearly completed. Necessarily, engine designs have had to be changed to develop the enormous power for driving a 20,000-ton ship at a speed of 17 knots. While large power installations for high speeds are not entirely faultless, it is reasonable to assume that the Diesel engine has made an entry into the most difficult marine field—express passenger service in the North Atlantic."

An interesting and a suggestive development in this field of marine engineering is the increasing adoption of oil-electric drive. The combination of the oil engine prime mover with electric generators and motors provides an economical system of propulsion of great flexibility and ease of control.

THE suction of an air compressor may in some locations cause objectionable noise and need muffling, just as the exhaust of an oil or a gas engine may require some sort of silencer. In line with this procedure, the Maxim Silencer Company of Hartford, Conn., makes the following report of recent installations of their equipment:

One 12-inch silencer on the suction of a 2,200 cubic-foot-per-minute compressor operated by the Farrell Foundry & Machine Company of Ansonia, Conn.

One 10-inch silencer on the exhaust of a 200-H.P. engine operated by the Murand Ice Company, Edgemere, Long Island.

Two 4-inch silencers on the intakes of air compressors used by the Flint Spring Water Ice Company, Flint, Mich., for agitating the water during freezing.

One 4-inch silencer on the suction of an air compressor operated by the Citizens Necessity Company, Toledo, O., for water agitation.

In the case of the 12-inch silencer, it is reported that with the silencer in service the suction noise cannot be heard ten feet from the inlet.

This "Little Tugger" hoist provided the motive power for an aerial tramway by which building materials of various sorts were lifted from the river level to working points on the bridge approach.

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EDITORIALS

ANOTHER GREAT TASK FOR THE ROCK DRILL

THE DEEPEST mines today are mere scratches in the earth's crust compared with the 12-mile shaft Sir CHARLES PARSONS recommends sinking for the purpose of possibly revealing some of Nature's secrets. Incidentally, we might remark that the mines in question are producing precious or marketable ores which warrant digging away some thousands of feet below the ground's surface, while Sir Charles naively points out that his project, to cost perhaps $100,000,000, may very likely prove of no monetary value.

This eminent engineer is correct in asserting that we do not now know what is beneath our feet twelve miles down; but it is debatable whether we can make a commensurate gain in knowledge if we spend $100,000,000 in driving a 20-foot shaft that deep into the crust of this globe of ours. In passing, we might keep in mind the fact that it is substantially 4,000 miles to the earth's center; and unquestionably much—very much—that is most important to animate existence has its source of action far, far below the bottom of the hole which Sir Charles would have the nations combine to drill—urging modestly that we subscribe the major share.

The rock drill has worked wonders for the betterment of humankind, and its field of usefulness widens continually with steadily increasing benefits to one and all of us. Literally, mountains are moved, immense passages are made, and innumerable obstacles are cleared away by means of the rock drill—the sum total of which would represent many times the mass of rock in a shaft of the dimensions proposed by Sir Charles; and the rock drill would be the only instrument by which he could hope to reach his goal.

When everything is considered, isn't the master work of this air-driven tool along those lines with which we are familiar and in which it has done so much for our material progress—no matter how ignorant we may remain about terrestrial conditions a dozen miles underground?

A WELL-EARNED TRIBUTE

IT IS eminently appropriate that the New York-New Jersey vehicular tubes should henceforth be known as the Holland Tunnel. Not only were CLIFFORD MILBURN HOLLAND'S days shortened by his untiring devotion to the burden placed upon his shoulders as chief engineer in charge of this great undertaking, but his technical skill and profound knowledge of the difficulties of the task are not yet generally appreciated by the public which will benefit through his labors and his self-forgetfulness.

From the very day of his graduation in his chosen calling, Mr. HOLLAND allied himself with the problems of subaqueous tunneling successively developed during the construction of the various tubes driven under Manhattan's flanking rivers. Year by year his accumulating experience and the faithfulness with which he discharged the duties assigned him made him an inevitable figure in that special department of engineering. Therefore, it was not unexpected when he was chosen to supervise the master job, the driving of the big twin tubes beneath the Hudson for vehicular traffic between New York City and near-by New Jersey.

It was CLIFFORD M. HOLLAND'S convincing advocacy of the finally accepted type of structure that saved the taxpayers concerned from a very costly and possibly a monumental failure. It was his firm stand and unanswerable array of facts which kept the associate commissions from deciding upon a tunnel lined with concrete blocks instead of one fashioned of unit rings of cast steel. Similarly, he showed that two tubes of the accepted dimensions would have many advantages over a much larger single tube capable of accommodating traffic on two levels.

Personally, CLIFFORD M. HOLLAND was a very lovable character, but he was a two-fisted fighter when it came to the support of any technical problem in which he was convinced his stand was right. No higher tribute can be paid to any official in public life than to say that his first thought was always of the trust imposed in him. This is undoubtedly true in the case of Mr. HOLLAND; and the tunnel in question will bear lasting testimony to his splendid qualifications and to the wisdom of those responsible for his selection.

ADDING TO OUR COMMERCIAL CONTACTS

WITH excellent judgment, the United States Department of Commerce has recently seen fit to open a branch office at Ottawa, Canada. The promoting reason for this action lies in the fact that the Dominion is our second best export market—taking one-sixth of the merchandise shipped out of this country annually.

To quote from the departmental announcement: "The keenness of interest on the part of our business community concerning that market is demonstrated in the requests already submitted by our manufacturers. These services include a wide range of subjects, such as the sale of American textiles, radio apparatus, clocks, school equipment, scales, and advertising novelties. Furthermore, the office has been approached by prospective Canadian buyers of sundry lines. Due to the desirable location of the office, within striking distance of the more important commercial centers of Montreal and Toronto, the Bureau's representative will be able to keep in constant touch with the major phases in the industrial development and commercial trends of the Dominion."

It is not difficult to picture the possible usefulness of this outpost of commercial activity because the Ottawa office, by reason of its proximity to the United States, should be able to handle speedily any matters requiring immediate attention, especially whenever they relate to changes in the Canadian tariff or sales tax, import and export restrictions, customs regulations, and official statistics. It is evident that American industries can reach markets abroad only by having continually on the alert officials that have our industrial well-being at heart and who will lose no opportunity to add to our commercial success.

SEE AND KNOW AMERICA FIRST

IT HAS been the privilege of one of the editorial staff of this Magazine to make a trip through a considerable number of the states which constitute the Union. Much of the territory traversed was new to him, although born in this country as his grandparents and great-grandparents were before him.

Familiar as he is with many parts of Europe, his wanderings revealed to him the no-less impressive wonders of our truly wonderful nation. They showed how amazingly bountiful Nature has been to us as a people; and he discovered, what he never truly understood before, how each section of the land is dealing with its problems as it sees them daily and at close range. Further, there were disclosed industrial, municipal, and social developments and achievements of which he knew little if anything. Some of these will be treated from time to time in our pages, but many of them will necessarily remain memories, impressions, and food for thought.

One thought, however, persists: If more of us could see more of our own land and our own people—know our fellow Americans and our material heritage better—surely the bonds that bind us would be stronger and our pride in our national birthright infinitely greater. In short, we should be richer in understanding, far broader in our tolerance, and have a greater recognition of our community of interest.

IS WIND POWER AGAIN TO DRIVE SHIPPING?

FOR decades, the number of sailing craft has steadily dwindled, and even the motor-driven fisherman has become a commonplace despite the fact that for centuries it made its way into the offing and back again to port under a spread of canvas which utilized the propelling power of the free winds. It is, therefore, with no small measure of curiosity—not to mention skepticism—that the world has heard latterly that the Germans have devised a sailless type of vessel which sails or, to be exact, utilizes the wind to help to drive it onward upon a chosen course.

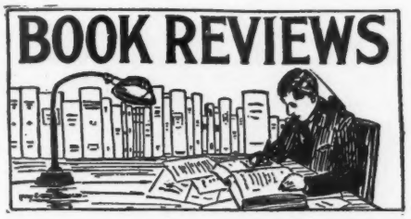
Up to date, the details of this invention have been withheld, but we are advised that HERR FLETTNER and his associates have brought into being an order of craft which may revolutionize maritime transportation—especially when placed upon routes over which blow for prolonged periods favoring trade winds or monsoons. The descriptions so far available reveal that in place of sails the boat is equipped with tall revolving cylinders of thin sheet steel, and that these cylinders when turned in opposition to the course of the wind exert force at right angles to that air stream. This, so it seems, is in agreement with the "Magnus law"—a principle of aerodynamics discovered about the middle of the nineteenth century.

Whatever may be disclosed in the near future about this invention, the fact remains that the purpose is really to utilize the force of the wind as an auxiliary to the prime mover, which may be either a steam engine or a heavy oil motor, thus saving, possibly, a substantial percentage of fuel.

A CORRECTION

We published in our November issue an article entitled *Compressed air for the combustion of gas.* Through a misunderstanding the original text at the end of the third paragraph was altered to read: "It does not depend upon furnace back pressure for operation." The line should run, instead, "It is entirely independent of furnace back pressure."

Sir Sidney Kidman, the Australian cattle king, owns what must be the world's largest farm. It embraces more than 40,000 square miles, an area roughly equivalent to the whole of England less Yorkshire and Devon. Don Luis Terraza of Mexico, with 8,000,000 acres or one-third less land, has a greater showing of stock, totaling 1,000,000 head of cattle, 700,000 sheep, and 100,000 horses. Perhaps third on the list is Mrs. King, whose cattle and sheep ranch in the United States is fenced in by 300 miles of barbed wire.



SEASONAL OPERATION IN THE CONSTRUCTION INDUSTRIES, by a Committee of the President's Conference on Unemployment, with a foreword by Herbert Hoover. A book of 213 pages, published by McGraw-Hill Book Company, Inc., New York City. Price, $2.50.

THIS report, with its recommendations, carries to further conclusions certain researches instituted several years ago for the purpose of ascertaining the facts associated with unemployment in industry and of devising remedies by which employment might be stabilized and work assured certain groups of wage earners throughout the whole of each twelvemonth. It is not necessary here to lay emphasis upon the importance of investigations of this sort, especially when the authorities engaged in it have found it possible to suggest rational and practicable methods of correction.

In his foreword, Mr. Hoover says: "The Committee has well demonstrated the most important fact that the seasonal character of the construction industries is to a considerable extent a matter of custom and habit, not of climatic necessity." With this keynote, the earnest searcher for solutions of some of our industrial problems will find in this book a wealth of convincing evidence that the seasonal situation of the workers concerned is susceptible of substantial improvement—making for the benefit of the worker, the contractor, and the general public.

BRAINS IN BUSINESS, by Frank A. Nagley, School of Business Administration, University of Oregon. A work of 317 pages, published by A. C. McClurg & Company, Chicago, Ill. Price, $2.00.

THE alluring title of this book does not really describe the reason for its being. What the author has had in mind was the writing of a book which would show how brains could be employed to advantage in different departments of the world of business. As he sees it, all men, no matter what may be the measure of their individual mental gifts, need inspiration from time to time to spur them on to their best and highest endeavors.

For more than three years, Mr. Nagley spent his entire time selecting employees for two very large industrial concerns. During that period he interviewed more than 100,000 applicants for positions. A good deal of time and thought was spent in studying men at work, finding out how to fit each into a more suitable or agreeable line of effort; learning why some failed where others succeeded; why the majority merely drifted; why many were discouraged; and why a considerable number was sullenly rebellious.

The pages of this excellent book are full of food for thought and valuable suggestions to officials or other persons upon whom rest the responsibility of clarifying the conditions associated with the numerous personnel of any good-sized industrial organization. The volume also gives concrete examples of how the discouraged worker may be heartened and the fearful encouraged to push forward to success.

EYE HAZARDS IN INDUSTRIAL OCCUPATIONS, by Louis Resnick and Lewis H. Carris. This illustrated volume of 247 pages is published by The National Committee for the Prevention of Blindness, Inc., New York City. Price, paper bound, $1.50, fabrikoid bound, $2.50.

THE fact has repeatedly been brought to the attention of the public that much needless suffering and economic loss have resulted from a lack of safeguards to the eyes of the industrial worker. The need of further spreading this propaganda of precaution and protection is undiminished, and the report under consideration is a timely and a very informative contribution to this general movement toward the elimination of eye hazards in industrial occupations.

As the authors express it: "The science of human rehabilitation has developed artificial hands, arms, and legs that can do almost anything the human member can do. But no one has yet produced an artificial eye that can see. Nor does anyone dare predict that the day will ever come when it will be possible to replace the human eye with an artificial eye that will see."

We heartily recommend this book to all executives that have to do with any department of industry wherein the proper condition of the eyes of employees is a matter of concern for one reason or another.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTE, for the year ending June 30, 1922. An extensively illustrated book of 554 pages, issued by the Government Printing Office, Washington, D. C. Price, $1.50.

THE present volume, like most of those preceding it, contains reprints of scientific papers from many sources touching upon a wide variety of subject matter. It is not practicable within the space available to review any one of the topics dealt with: each should make a strong appeal to some seekers after scientific truths. However, probably most of us could read with pleasure and instruction those papers which touch upon the age of the earth and the deepness of the ocean. One admirable feature about well-nigh every one of these valuable essays is the simple, lucid language used by their authors.

ONE HUNDRED AND ONE WAYS TO SAVE MONEY WITH PORTABLE AIR POWER, is the arresting title of a pamphlet of 71 pages issued by the Ingersoll-Rand Company, New York City.

THIS admirably arranged and copiously illustrated booklet is intended to disclose just how the hard-pressed contractor and others can master many sorts of problems despite the fact that he may not always have at his command an unfailing supply of skilled workmen. Again, the pamphlet reveals how the worker, himself, can accomplish more with less bodily stress by reason of the labor-lightening capacities of different kinds of air-driven tools designed largely for this purpose.

The book will be sent free to anyone upon request, and may be had by applying either to the head office in New York or to any of the numerous branches of the company maintained throughout the United States and abroad.

DIGGING WELLS FOR OAKEN BUCKETS

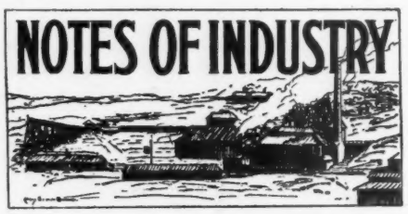
RECENTLY, while on a vacation in Vermont, the President of our great Republic presented Henry Ford with an old oaken bucket. At that time probably no less than a million minds turned back to the days when, as boys and girls, drawing water from the family well was a daily chore. With these memories still fresh in our minds, the latest chapter written into the ancient art of well digging should be of interest in that it brings out how modern machinery is being adapted to tasks hitherto done by hand labor.

Out in the State of Washington, where vast cut-over timber lands are rapidly being turned into arable acres by the tillers of the soil, a resourceful contractor has devised a method of digging wells whereby from three to six can be sunk in the time that it takes to dig one by pick and shovel.

In the North and the West the well digger is apt to encounter layers of so-called hardpan, impermeable strata of clay, that necessitate the use of a pick or similar tool. The wells, as ordinarily dug, are approximately three feet in diameter and offer little room in which to swing the time-honored hand pick effectively. Therefore, the contractor in question has discarded his pick for the familiar air-operated paving breaker which needs so little elbowroom that it is admirably suited for the task. As previously mentioned, it makes it possible to cut down the time required to sink a well to from one-third to one-sixth that needed when doing the work in the old-fashioned way.

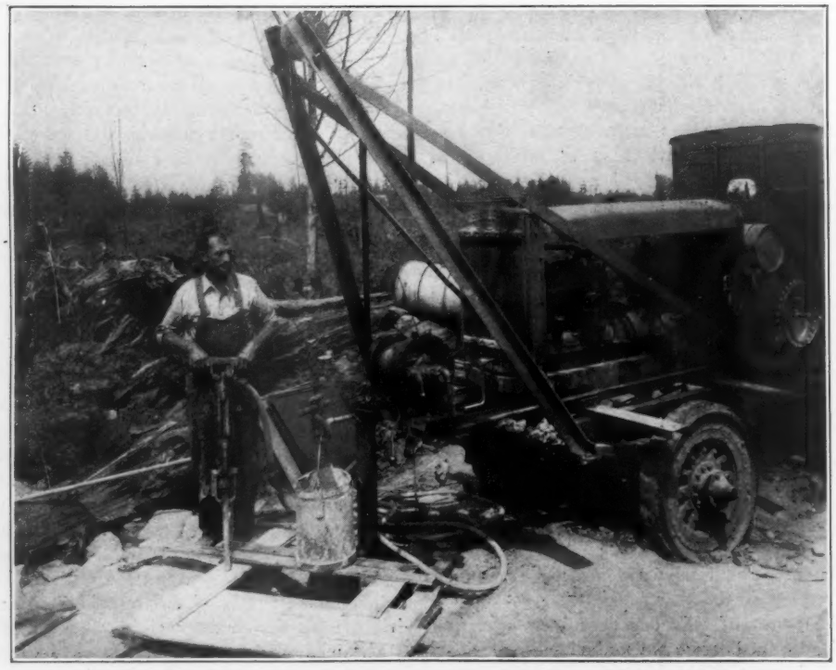
Air to operate the paving breaker is furnished by an Ingersoll-Rand, Type-Twenty, portable compressor mounted on a truck, as shown in the accompanying photograph. This machine also supplies air to actuate a "Little Tugger" hoist—mounted derrick fashion on the rear end of the truck—which is used to raise the excavated dirt. But two men are required to do the digging: one, in the well, operates the paving breaker and fills the bucket, and the other, at the surface, attends to the compressor and the hoist. A convenient signal system between the men suffices to keep things running smoothly.

The outfit, as illustrated, was assembled by the contractor. He bought a standard portable compressor without the running gear, mounted it on a truck, built on the derrick frame, hooked up the hoist, and thus was ready for business.



In Italy, as elsewhere, the problem of reducing the cost of living is one of distribution rather than of production. In an attempt to improve conditions, it is urged that the railways give special consideration to the shipment of food products and that provision be made for more refrigerator cars and increased cold-storage facilities.

The Baltimore & Ohio is the oldest trunk-line railroad in the United States, having been incorporated in 1827.



Some of the air-driven equipment used in the State of Washington for digging wells for domestic purposes. These facilities have greatly lightened labor and speeded up work in a field of effort which has hitherto been slow and tollsome.

A "Fairey" seaplane has been built in England for service in British Guiana between the plantations of a large company and the nearest township. The machine is specially designed for carrying white men, who fall ill with fever, to the nearest point where reliable treatment is obtainable. As the journey by land requires seventeen days—rapids in a river *en route* compelling porterage, etc.—many sick men have died on the way. The seaplane will cover the distance in a little over two hours; and telephone and wireless communication make the arrangement a perfect one.

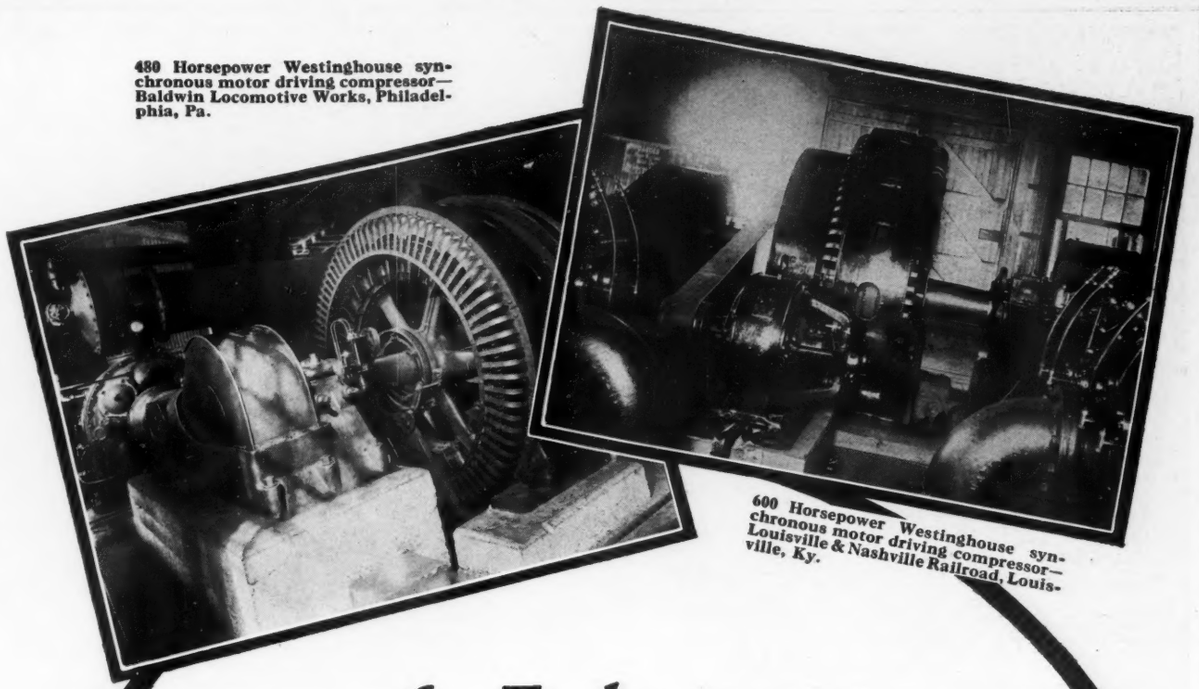
According to statistics, collected by the United States Geological Survey, the average electric generating plant turned out a kilowatt-hour with 3.2 pounds of coal in 1919 as against a consumption of 2.4 pounds per kilowatt-hour at the present day. This reduction in fuel outlay is an impressive indication of the economies that have been achieved through skilful engineering practices.

In a recent paper on the subject of *The sun as a source of power,* Mr. C. LeRoy Meisinger says that in certain subtropical regions where coal is scarce, such as Egypt, the Punjab, and the Karoo of South Africa, boxes are used as ovens for cooking as well as for other purposes. These boxes, which are made of teakwood, are blackened inside and fitted with glass tops. When properly insulated, they have been found to register from 240 to 275°F. at midday; and with the addition of a mirror the temperature within has been known to reach as high as 320 degrees.

Near Bellefonte, Pa., is a small lake of considerable value to the farmers and fishermen of the neighborhood. The water in the lake is maintained at the desired level by a dam, 200 feet long, which has been giving out and failing in its function. As the cost of repairing the structure seemed prohibitive, nothing was done; but, fortunately for those depending on the water, a group of beavers took hold of the matter and skilfully mended the dam.

Although manufacturing has been steadily gaining in Canada within recent years, agriculture still remains the leading industry of the Dominion. Between 2,500,000 and 3,000,000 persons are gainfully engaged in farming, while from 500,000 to 600,000 are employed in manufacturing establishments. Of the latter workers, 80 per cent. are concentrated in the provinces of Ontario and Quebec.

During the construction season of 1923, the latest figures available, 79,000,000 square yards of concrete pavement were laid and opened to traffic in the United States. This constitutes a record performance. About 55,000,000 square yards of the total, or the equivalent of almost 5,200 miles of concrete road 18 feet wide, were added to the nation's permanent highway system, while the remainder was placed on city streets, etc.



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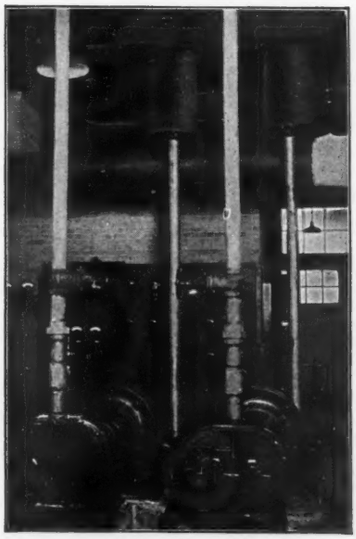

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USED IN THE HUDSON RIVER
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Booth & Flinn, Ltd., have added another history making feat to their already long list of engineering accomplishments. The climax of this undertaking was the holing through of the first tube of the great Hudson River Vehicular Tunnel on October 29th.

This tunnel will constitute the most important artery for relieving the very congested traffic between New York City and New Jersey with which the present ferry facilities cannot efficiently cope.

The responsibility for the stupendous project was well placed in Booth & Flinn, Ltd., who previously had successfully completed the Liberty Tunnel, Pittsburgh; sections of the New York Subways; sections of the New York City Aqueduct, etc.

We are proud of the fact that on the Vehicular Tunnel, as on the previous projects, Booth & Flinn, Ltd., relied so confidently on Ingersoll-Rand Compressors, drills, hoists, pumps, pneumatic tools, etc. We are also proud of the fact that their confidence was so well repaid by the satisfactory performance of this equipment.

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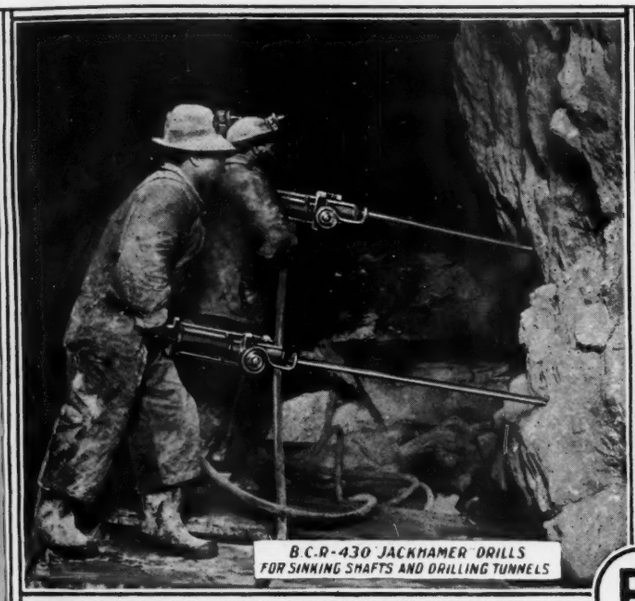

B.C.R-430 JACKHAMER DRILLS FOR SINKING SHAFTS AND DRILLING TUNNELS

D.C.R-23- JACKHAMER DRILL FOR SINKING SHAFTS AND DRILLING TUNNELS.

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Both the original type, BCR-430, "Jackhamer" and latest type, DCR-23 "Jackhamer" (shown above) were used for excavating in the rock section of the tunnel from the start to the holing through.

Ingersoll-Rand Compressors furnished compressed air not only for operating the various tools but also for the caissons and tunnels. This is the fourth great tunnel on which Booth & Flinn, Ltd., have used these identical compressors. The other three tunnels were under the East River connecting New York City to Long Island.

Back of the machinery was Ingersoll-Rand Service—the kind of service that helped to maintain the high progress rate. Complete machines and parts needed were furnished from nearby I-R storerooms: service-men and engineers were quickly available for practical aid and advice.

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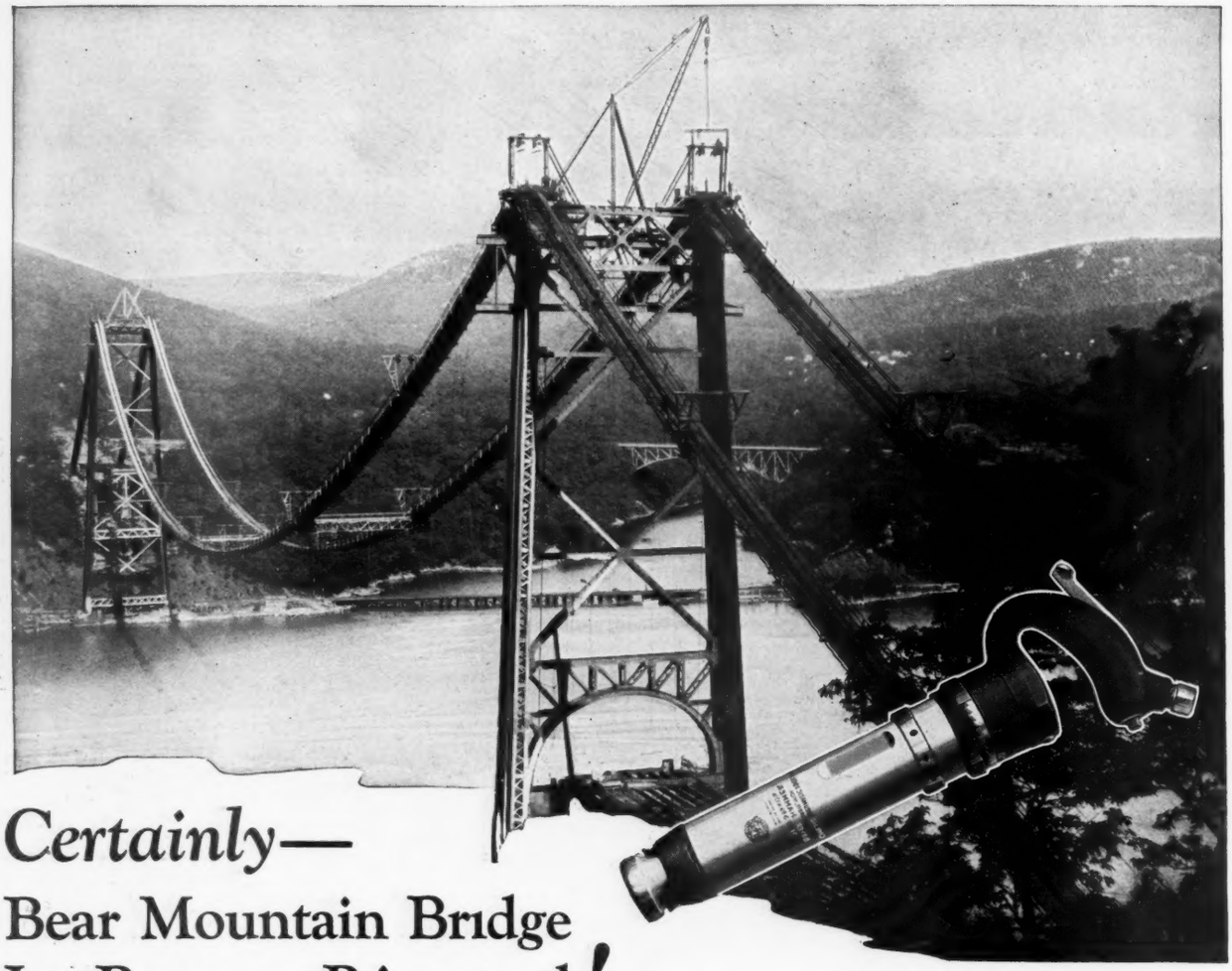

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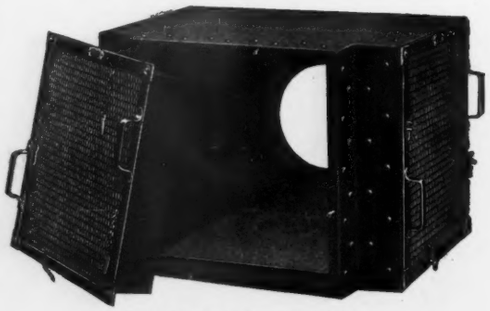
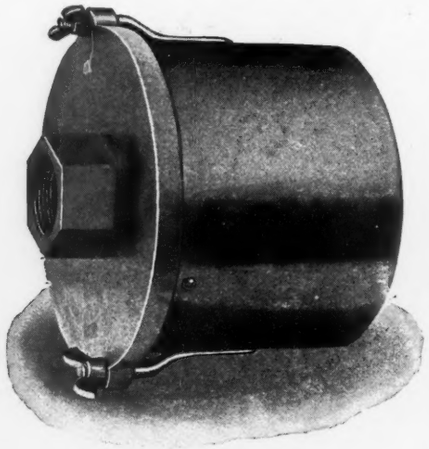


Reed Standard Compressor Filter for air compressor and engines up to 4200 C. F. M. capacity.



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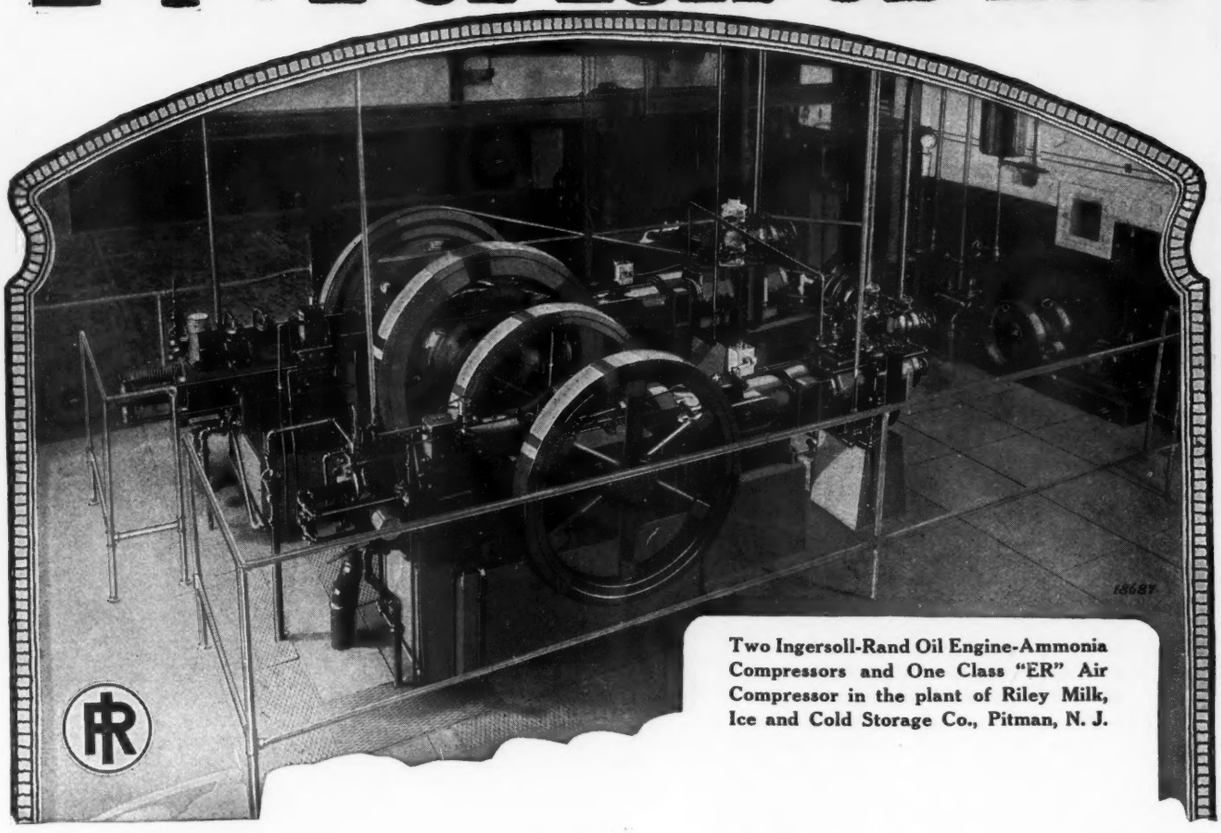

Two Ingersoll-Rand Oil Engine-Ammonia Compressors and One Class "ER" Air Compressor in the plant of Riley Milk, Ice and Cold Storage Co., Pitman, N. J.

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Even if there is no process dust in your plant, normal atmospheric dust is not only forming so called "carbon deposits" in your air compressors and internal combustion engines, but it is also cutting down the sustained efficiency of these machines. Like the user quoted below, you need clean air for your equipment.

A Letter from a User

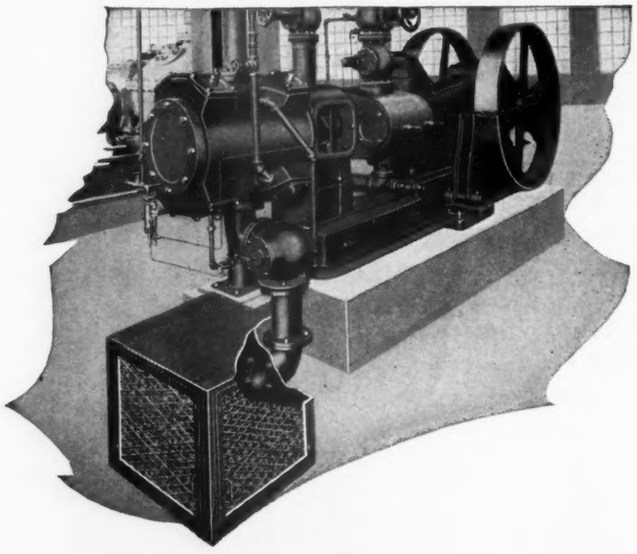
"In answer to your inquiry concerning the Midwest Air Filters installed in the air intake to our No. 4 air compressor.

These filter cells were installed in January of this year. After 475 hours of operation we removed some of the intake and discharge valves from the machine for inspection, and found them entirely free from the dust and dirt which coat the valves of our other compressors.

We have no doubt that these valves can be run for several years without cleaning. This will mean the saving of about ten days' labor twice a year in addition to the saving due to the sustained efficiency of the machine from operating with clean valves.

The resistance due to the nine filter cells handling about 5000 cubic feet of air per minute is about three-eighths of an inch of water."

There are many other advantages of clean air. Write Department F-5 for a copy of Data Book B, which covers the entire story of Midwest Air Filters in detail, and outlines the various types and sizes provided for every kind of machine with capacities from 10 to 10,000 cubic feet of air per minute or more.



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The Ricardo Head

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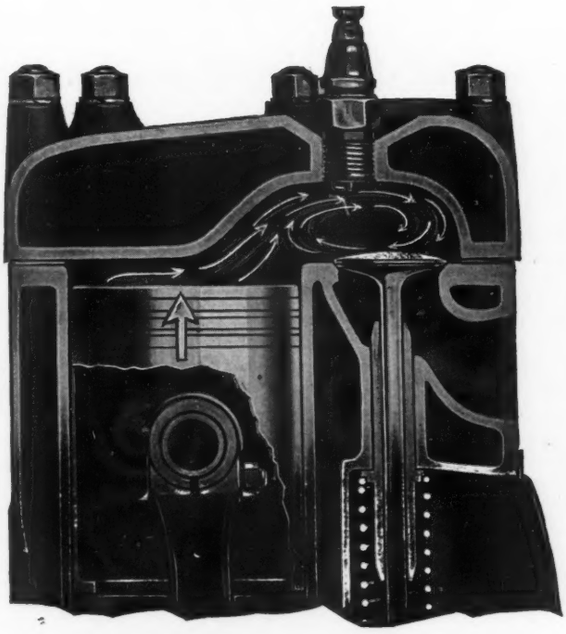

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We guarantee every installation to give complete satisfaction.

Range of Sizes for Portable Compressors

Model C-0	Model C-1	Model C-2	Model C-3	Model C-4	Model C-5
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Diam. 3½"	Diam. 4¼"	Diam. 5½"	Diam. 5½"	Diam. 6⅜"	Diam. 9"
Height 4½"	Height 5½"	Height 7"	Height 8½"	Height 9"	Height 12½"
Weight 8 oz.	Weight 16 oz.	Weight 26 oz.	Weight 34 oz.	Weight 38 oz.	Weight 96 oz.
Thread 1¼"	Thread 1¼"	Thread 1½"	Thread 1½"	Thread 2"	Thread 3"
Price $7.50	Price $12.50	Price $15.00	Price $17.50	Price $20.00	Price $30.00

Note: C. F. M.—Cubic Ft. Free Air per Minute. (Capacity). Height—Overall dimension including Thread. Thread—Standard Pipe Thread.

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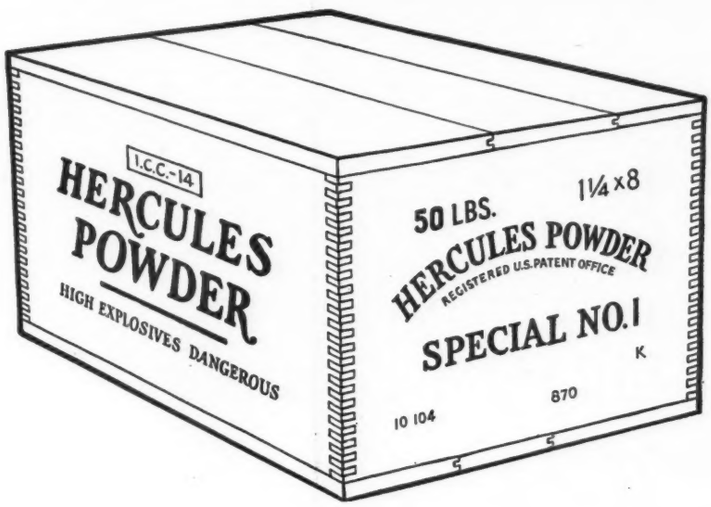
The Explosive for You is in This List



Hercules Special No. 1 because of its high cartridge count and low cost per cartridge is more economical on work for which it is suited than other explosives. It frequently replaces 40% dynamite, cartridge for cartridge, at a saving of at least 25%. For quarrying, open pit mining, road building, and some underground work it is effective and economical.

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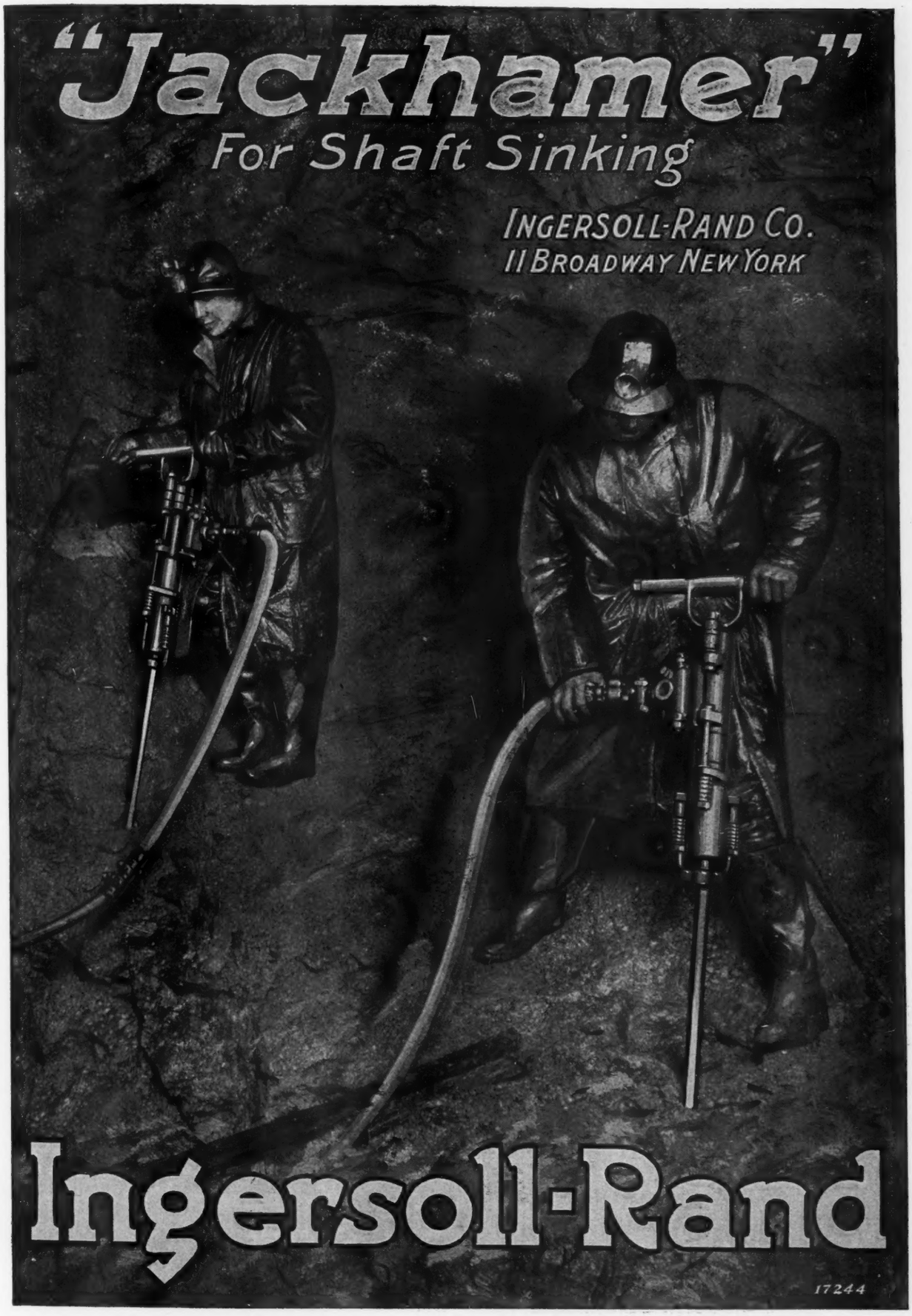
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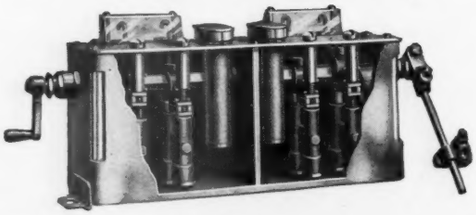

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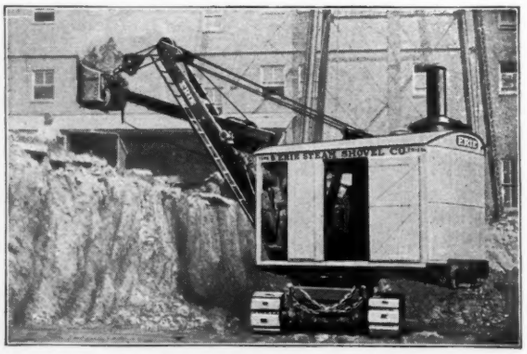

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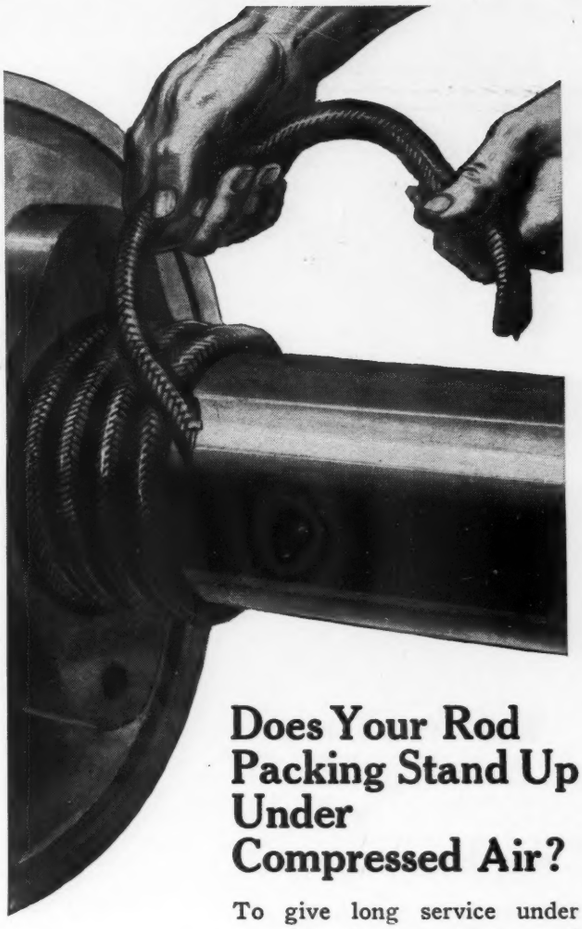

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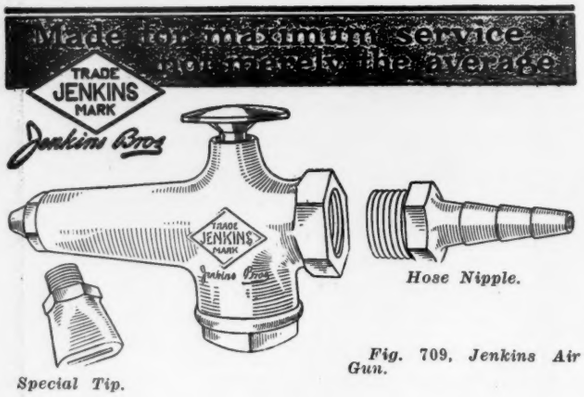

Fig. 709, Jenkins Air Gun.

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Fig. 108, screwed, Standard Bronze Angle Valve, fitted with Jenkins Renewable Disc.

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Fig. 141, screwed, Standard Iron Body Globe Valve, fitted with Jenkins Renewable Disc.

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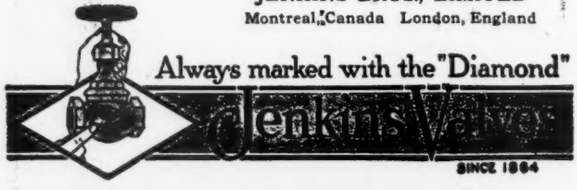

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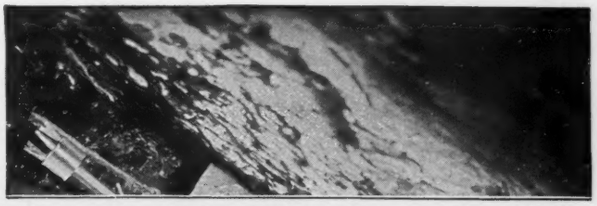

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AIR HOSE

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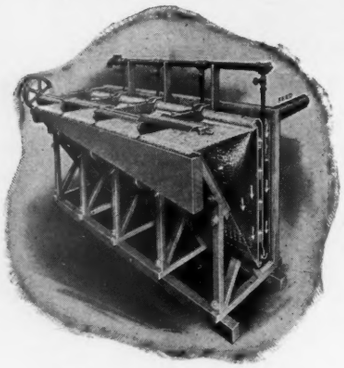

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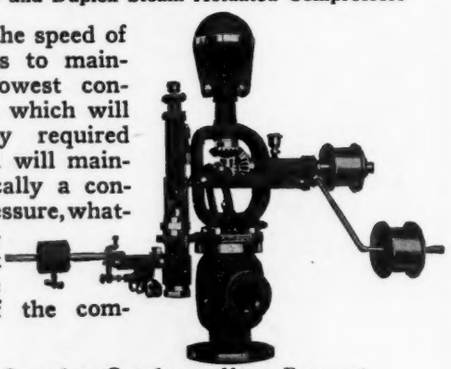

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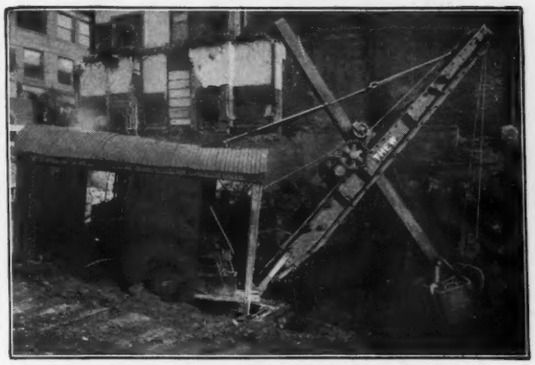

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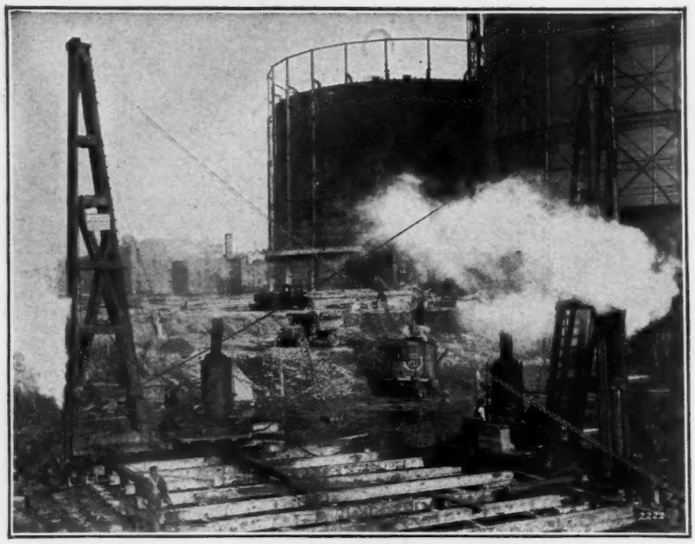

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